THE CURE OF CLUBFOOT WITHOUT CUTTING TENDONS

BARWELL.

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ON

THE CURE OF CLUBFOOT

WITHOUT CUTTING TENDONS.

ON THE

CURE OF CLUBFOOT

WITHOUT CUTTING TENDONS;

AND ON CERTAIN

New Methods of Treating other Deformities.

BY

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PREFACE.

The bare nucleus of the ensuing pages was introduced to the Profession in 1861 by a Paper read before the Medico-Chirurgical Society,* entitled "On Certain Grave Evils resulting from Tenotomy; and on a New Method of Curing Deformities of the Foot." The history of its production is as follows:—From a very early period of my professional career I have paid much attention to joint diseases, and to methods of remedying lameness thereby produced. Among such cases lameness from other causes came frequently under my observation. I studied these maladies from the ortho-

* Published in the "Medico-Chirurgical Transactions," vol. xlv., p. 25.

pædic point of view, and while tenotomy was still almost a novelty in England, was so charmed with the easy change of form, which after such an operation could be produced in most distortions, that I became an almost enthusiastic admirer of the procedure. After, however, following up carefully a large number of these cases, I was pained to find in how many of them the deformity more or less returned; in how many more a different, an opposite distortion supervened; while power over the limb was actually injured or destroyed in so large a majority of instances, that its retention appeared absolutely exceptional.

About this time, while making, for the purpose of acquiring a sure power of tenotomy, an unusually careful dissection of the tendinous, fascial and ligamentous structures about the foot and ankle, I was struck by observing

that the anatomical conditions of most tendons were much against the probability, even the possibility, of their free and unencumbered re-union. This fact, coupled with the sort of lameness produced by tenotomy, very much abated my predilection for the operation.

A further study, interrupted by other demands of practice, and resumed as occasion might require, convinced me that Deformities of the Foot, the so-called *talipes*, all primarily affect the front half of the limb, and that the mechanical and after-treatment of club-foot by shoes, all of which act primarily and principally on the ankle-joint, was manifestly ill adapted for the purpose in view. This fresh insight furnished the clue, which enabled me to discover the causes of the above-mentioned failures in treatment. I perceived, namely, that to fasten the sole, which ought to be mobile and free, upon a stiff iron, and to

force the contracted muscles, *while at rest*, into a new posture, could only be a temporary remedy for the contraction, and must be an injurious or fatal augmentation of the paralysis, which is the "head and front of the offending."

From that time I tasked myself to find some means of exerting upon the part primarily and principally deformed (the anterior half of the tarsus) some force which, instead of squeezing an inactive foot into, as it were, a moulded and inactive shape, should guide active but abnormal movement into its normal direction and relationship. The reader who follows out carefully and skilfully the procedures subsequently described, will judge how far I have failed or succeeded: the treatment is not represented as simple and easy; but for myself I can only say, that the more I see of deformities, the more reason have I to be satisfied with its results.

It would have been strange if my gradually-growing distrust of tenotomy had not influenced my practice in other cases besides in distortions of the feet. A former work,* in which, among other subjects connected with joint-disease, the "Restoration of Crippled Joints" is handled, had of course brought much additional means of experience in that particular branch; and I found myself more and more induced to refrain from dividing tendons and muscles, so that such procedure has become exceptional in my practice. A natural association of ideas in the contrary direction originated the thought of transferring the same method of treatment I employed in stiff joints to deformed feet, and the cases I have had of sudden restoration of posture under chloroform fully justify the conclusions I had formed.

It should be remarked, that in choosing

* "A Treatise on Diseases of the Joints."

cases for illustration I have purposely avoided selecting the worst instances of each deformity: the type of such disease lies at neither extreme, but midway between severe and slight distortion. Neither have I considered it seemly or professional to give representations of limbs "before and after treatment."

There only remains for me to add, that if in the course of the following work phrases have been used, which might appear somewhat severe, they will be, I hope, ascribed to my zeal for true principles, and not to any personal feeling.

RICHARD BARWELL.

22, Old Burlington-street,
March 22, 1863.

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CHAPTER I.

INTRODUCTORY.

It does not come within the scope of the present work to consider the various theories concerning the origin of club-foot, nor to enter into its pathology, further than will be necessary to show why the present fashion of cutting the tendons is faulty in theory, and injurious in its consequences; why the shoes and other such instruments are false in design and construction; and why the plan of

treatment which I have now carried on for some little time, both in hospital and in private practice, is founded in reason and satisfactory in result.

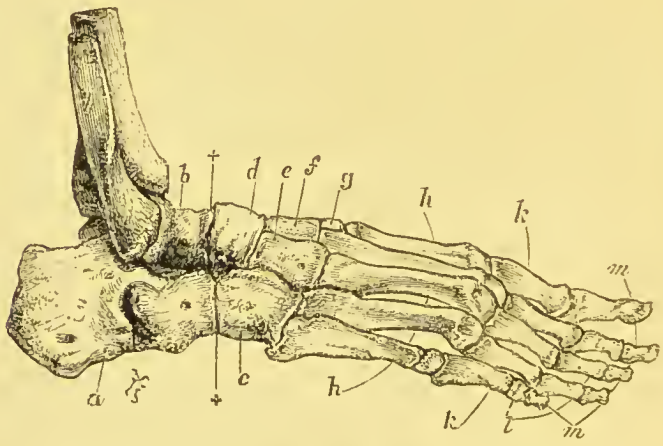
The foot is articulated to the two bones of the leg by the astragalus, the parts together forming a tenon and mortoise-like joint, which permits of four movements, flexion (turning up the toes); extension (pointing the toes); inward rotation (turning the sole inwards, so that the outside rests on the ground); outward rotation (turning the sole outward, so that the inside rests on the ground).*

* Turning the toes out is produced by an action of the whole limb, if the knee be straight; if it be bent, it is effected by a rotation outward of the fibula, brought about by the attachment, through means of the fascia lata, of the *tensor vaginæ femoris* muscle to the head of that bone. Thus the whole fibula can, when the knee is bent, be rotated outwards by the action of that muscle; the anterior ligament, which runs forward from the outer malleolus to the astragalus, appears especially constructed to make the foot follow this movement of the fibula.

The two first are free, the two last very limited. The action, called turning the toes out or in, is not so much a motion of the foot in the joint, as a movement of joint and foot together. Of course for each of these movements one or more muscles must be adapted; but it may be permitted me here to remark, that hardly any movement is entirely the act of a single muscle. These organs combine among themselves to abet or to limit each other's action in so remarkable a way, that even at the present time the mechanism of some apparently simple movements is not, I believe, properly understood, a fact whereof we shall see some examples in the sequel.

But the foot which we have hitherto contemplated as a whole, is on the contrary made up of twelve bones (leaving out the toes), each more or less movable on the others, and the muscles

which move the limb in the above directions have also the office of keeping these parts in that position and relationship to each other which constitutes the harmony and beauty of the exquisitely constructed support. The heel-bone behind, and the metatarsus in front, form the buttress and flanks of an arch; the weight is placed over the hinder flank, that is, over the first third of the



SKELETON OF THE FOOT, SEEN FROM THE OUTER SIDE.

a, Os calcis; *b*, astragalus; ** The medio-tarsal joint, running right across the foot, and separating into an anterior and posterior portion; *c*, the cuboid; *d*, the scaphoid, or navicular; *e*, outer cuneiform; *f*, middle cuneiform; *g*, a small bit of the inner cuneiform; *hh*, metatarsal bones; *kk*, first phalanges; *l*, second phalanges; *m*, unequal phalanges.

whole distance between the heel and the root of the toes; the crown of the arch is formed by a number of small bones, (cuboid, scaphoid, and three cuneiform bones) all so movably yet so indissolubly jointed together as to combine great flexibility with the necessary strength.

The arch of the foot has often been a subject of eulogium, but we are to observe that if it were a solid arch, like that of a bridge, such praise would be misplaced. Even granting any amount of flexibility, if the weight had been placed upon the middle, or at either end, the arciform build would have been of very little service. But the weight is placed over the solid hinder flank, giving the desirable stability to the posture, yet not so far back but that part of the burden is supported by, and with very little effort the whole can be thrown upon, the front flank of the arch. Thus we see that the solid hinder buttress is made for

stationary strength, while the front one is adapted for buoyant movement. Indeed, man, having an instinctive feeling of this fact, plants his heel firmly on the ground when about to raise a weight or resist a shock, but gets on the toe when starting for a race. The front of the foot could not, however, carry the body safely, if it were a single buttress with but one point of support like the heel; it is, on the contrary, much broader, and contains two points of support, one on each side, and between these a lateral arch is turned by the position of the tarsal and metatarsal bones. Thus is the elasticity of the limb still further secured.

Of all the joints in the front of the foot, the chief agent in its flexibility and security is one, that runs across its whole breadth just in front of that part, which supports the weight. It lies between the astragalus and os calcis behind, and the scaphoid and cuboid in front, and is

very well named the medio-tarsal joint. It allows of flexion and extension, adduction and abduction, also rotation inwards and outwards upon the long axis of the foot. These movements are very important in a physiological point of view, therefore in a pathological and practical one for the subject now under consideration. We will first give a little attention to the last of these movements. As the front of the foot rests on a broad base, or on two buttresses, it follows that when the ground slopes laterally this base must take the same direction. If the whole foot were obliged to follow this movement, and, as the body must be perpendicular, there would result a necessity of continual and free lateral movement in the ankle; but, such arrangement being incompatible with strength, the change of direction is, through the medium of the medio-tarsal joint, delegated to the front half of the foot. The formation

of the extremity at this part is very different in different persons and at different times of life. There is about the feet of most young girls and women a flexibility that is quite remarkable. One may grasp the female foot, and holding the heel still, turn the front of it round till the sole looks almost directly inwards; although the other joints and although a twisting of the metacarpal bones help in such action, the great agent is the medio-tarsal articulation; the foot can also be curved laterally inwards till it is almost U shaped—and may be bent directly down and straightened up to a great extent; but it cannot be rotated much outwards, nor can it be bent laterally outwards. If we remember that the outside of the foot has two joints, between the calcis and cuboid and between the cuboid and metatarsus; that the inside has four between the calcis astragalus, scaphoid, internal cuneiform, and meta-

tarsus; if we consider that the inner part of the medio-tarsal joint is of the ball-and-socket description, the other more mortoise-like curving from above downward; if we also remember the disposition of ligament, and particularly of the calcaneo-cuboid, we shall see why that one joint is much more immovable than the three inner tarsal joints; and then if we observe, that as the foot is set down, the heel, the outer side of the sole, and the ball of the toes come to the ground, leaving all the inner side untouched, we shall not fail to perceive another example of that singular distribution of strength to one part and elasticity to the other, and to see why we can bend and twist the foot outwards hardly at all beyond its ordinary position.

These bones, admirably adapted as they are, would not for an instant keep their place unless supported and upheld by ligaments, muscles, and tendons.

It is not my intention to describe the various parts, but there are one or two points which I must mention, because a great deal in treatment depends on a just knowledge of the architectural and dynamic anatomy of the extremity, and this has not, to my mind, been rightly understood. In the first place, the office of keeping up the longitudinal arch of the foot is ascribed to the plantar fascia: but fascia and ligaments are never placed as the guardians of position; this task is always confided to muscular structures. Moreover, the greatest amount of curve is on the inside of the foot, therefore if the plantar fascia were the principal agent in keeping up the arch, its strongest part should be on the inside; but this is exactly the weakest part of the whole structure. Another very strong longitudinal ligament lying close to the bones, the calcaneo-cuboid, with its triple process to the three middle ossa metatarsi

(ligamentum laciniatum) is on the outside of the foot. Even the muscles which run forward to the phalanges have but little influence on the curves of the tarsus, except while acting on the toes. If, however, the construction of the foot be considered in conjunction with that of the leg, it will be observed that the tendon of the tibialis anticus muscle (which arises in the leg above the front of the foot) hooks round the os cuneiform, and is attached to its lower aspect and to the inner metatarsal bone, *i.e.*, to the highest point of the pedal arch. Thus we see that the construction is suspended to a sling, which, attached high above it, keeps up the key-stone, and thus the whole edifice; not by an immovable ligamentous tie, but by a mobile force, which acts more or less, as the occasion may require.

It would be superfluous to enter into a description of the muscles and

tendons of the leg and foot, with their various actions; my reason for the foregoing details is, that the error which I have signalized is of the greatest importance in a practical point of view, and leads to one among the disastrous errors in the fashionable treatment of pedal deformity. There are in my opinion many such false notions concerning this part of the body; they will be pointed out and corrected as we encounter them when treating of its morbid actions.

To every one of the bones of the foot, with the exception of the astragalus, one or more muscles are attached, *i.e.*, either arise or are inserted; moreover, strong tendons glide through grooves in bones to which they are not otherwise attached, cross each other on the sole of the foot, where they become connected with other muscles whose very attachment therefore is movable, so that the limb as a whole, and in each particular, lies en-

tirely under the dominion of muscular force. It is to the even balance of power among the muscles that the foot depends for its efficiency and form; for it is easy to perceive that a slight preponderance or deficiency of power in one part or the other would throw a limb made up of so many nicely adjusted parts into some false form or position. And I must here point out that, with the exception of the tendo Achilles, every tendon passing from the leg to the foot is inserted in front of the medio-tarsal joint; thus every muscular contraction (except that of the sural muscles, producing raising of the heel and extension at the ankle,) acts primarily on the anterior half of the foot and medio-tarsal articulation, and only secondarily upon the back part and on the ankle-joint. This fact, which is most easily demonstrable on the feet of young people, is equally true, whether the direction of

the action be antero-posterior, lateral, or rotatory, whether the action itself be physiological or pathological. The importance of this doctrine will, it is hoped, be clear in the sequel.

CHAPTER II.

DEFORMITIES OF THE FOOT, AND THEIR PROXIMATE CAUSE.

A VERY few of the malformations of the foot originate in some congenital deficiency of the bones, and consequently of the whole apparatus, but these are rare, and lie out of our subject. The deformities, with which we have to do, are such as arise from abnormity of position; any changes of form which occasionally occur in the bones, being only secondary. Such malpostures are exaggerations and perpetuations of some natural position of the foot, or more correctly, absence of motion or restrain-

ing power in the opposite direction. Thus deformities may be divided into four cardinal divisions, corresponding to the four natural movements of the limb, namely, pes, or talipes equinus, talipes calcaneus, talipes varus, and talipes valgus. The first is exaggerated extension, the second excessive flexion, the third superabundant adduction, the fourth redundant abduction.* The several intermediate conditions can be designated by the combination of any two terms, as equino-varus, equino-valgus, and so on.

There is a cause assigned for the production of congenital club-foot, namely,

* The nomenclature of club-foot is not very scientific nor correct, but it has been in use some two thousand years, or nearly three, if we admit the Greek synonyms, and it answers the purpose sufficiently. The term *varus* (ῥαιβος) signified those deformities of the foot in which the toes were turned in; *valgus* (βλαισος) those in which the toes were turned out; thus I keep the terms extension, flexion, abduction, and adduction, although aware that such are by no means the only, or indeed the principal malpostures in these various deformities.

position of the *fœtus in utero*, which may occasionally have the effect named; but the theory is too speculative, and too far from the possibility of any proof, to be of value to us here.

Both congenital and non-congenital talipes are said to be produced by spasm or other abnormal contraction, and also by paralysis of certain muscles. Let us shortly examine the former doctrine. A muscle will adapt itself to any degree of length or of shortness, provided that degree be constantly preserved; thus, if we tie up an elbow or a knee in the bent position, and keep it so fixed for a month or six weeks, we shall find that the flexor muscles, which were kept short by that posture, cannot for a considerable time regain their former length; while the extensors, which have been kept long, cannot recover the power of contracting to their former shortness. Thus, when in the latter part of the last century people

left off wearing high-heeled shoes, the additional length of gastrocnemius, required to enable them to get the heel to the ground, could not be gained without considerable stretching and pain in the calf;* several cases are on record in which a painful ulcer on one part of the foot has caused the sufferer to keep that part from the ground until it became impossible to put it down.† Also, it is well known that children acquire, from imita-

* Camper, "Sur les Meilleures Especes de Chaussures." p. 28.

† This sort of shortening I have *elsewhere* described ("On Diseases of the Joints,") under the term contracture. Its pathology is more fully given in my Lectures on Hip Disease (*Lancet*, 1862 and 1863). The muscle having been kept within certain limits of length for a considerable time, the areolar and interfibrillous tissue, also the sarcolemma, retract to that length, like a scar beneath the skin, or in other fibrous structures. This is a physiological action whose intention is to give the fibres that support, which enables them to act within the limits of their diminished length more certainly and energetically, than they could do if the membrane, investing them and tying them into bundles, were to hang around them loosely and in folds.

tion or other cause, some awkward trick or posture which, if not corrected in time, will become so fixed, as fully to merit the name of deformity. Yet all such sources of muscular shortening are, as a rule, neither violent nor persistent enough to produce a permanent malposture, and thus are only among the very exceptional causes of deformity.

Infants are frequently, as is well known, subject to convulsions, and it is averred that sometimes, one or more muscles, which have during the attack drawn a limb into malposture, do not recover from the contraction, but continue to keep the limb distorted. Such a muscular condition would not be a contracture, as I have described it, since the convulsion never lasts sufficiently long, for any such organic process of areolar shortening; the state would be one of persistent, unvarying spasm, powerful enough to overcome the antagonistic

healthy muscles, and permanent enough to produce lasting change of form. uch condition does not only never come under our notice, but is I believe pathologically impossible. There are, no doubt, a few cases of peculiar paralysis of the voluntary power over the muscles, while the excito-motory function continues; and in the spasm of the whole set, the strongest organ will, of course, predominate.* In my experience, such state seldom continues long, unless there be either cerebral disease or deficiency, but terminates within a limited period, either in death or in complete recovery, or in simple paralysis in one set, and perfect restoration of power in another set of muscles; and this phrase leads us at once to the next object of our scrutiny.

* Voluntary power is as much used to control as to excite. The paralysis of this power is evidenced as much by violent and uncontrollable spasm as by incapability of subordinate movement.

Unfortunately, paralysis more or less partial and transient, or general and persistent, is extremely common with children; we find such condition left behind after convulsions; it comes on without convulsions, from irritation—intestinal, cutaneous, &c. It does not lie within the scope of this work to discuss the large range of infantile neuro-muscular disease, yet it must be permitted me to point out its two aspects; for instance, how *laryngismus stridulus*, or false croup, which by some is attributed to spasm of certain muscles, is by other authorities—and I believe with more reason—considered as paralysis of a different pair. Let it be observed, also, that the squint which may come and go with other symptoms of brain mischief, or may be a permanent affection, is certainly to be more rationally regarded as want of action in the outer rectus, which ap-

propriates the whole of one nerve (the sixth), than as spasm of the inner rectus, whose nerve supplies four other muscles of the eye and appendages. Certain also is it that some congenital deficiencies of the nervous system—whereof club-foot and club-hand are pretty constant accompaniments—as acephalosis, &c. &c., may, indeed must produce paralysis; but there is no evident connexion between such deformity and spasm. Then again, the legs and feet of children, even of adults, affected with talipes, are always very low in temperature and power of circulation; such condition is a constant accompaniment of paralysis, a contrary state is the ordinary attendant of spasm; moreover, muscular spasm is, as a rule, a very transient condition. One of the commonest complaints of children is accompanied by a dragging up and turning in of the toes, so as

closely to similate varus; but when the painful paroxysm goes off, the foot regains its natural posture, to be again distorted—and so on any number of times; yet there is no permanent impression left upon the limb.

Altogether, there can be no doubt that paralysis is very much more frequently the cause of club-foot than the opposite condition; indeed, my opinion, deduced from careful study of many cases, is, that spasm very rarely produces talipes. I mean, that morbid contraction of a muscle or set of muscles is hardly ever violent enough or persistent enough to cause any permanent alteration in the shape of the foot, while the opposers remain active.

On the other hand, it must be understood that the paralysis affecting a certain set of muscles produces deformity in the opposite direction. That is to say, paralysis of the flexors of

the foot allows deformity by extension, and *vice versa*. The mode of production is as follows:—Muscles, while healthy, are always kept at a certain degree of tension by "tonic contraction;" but when any one organ or any set of organs has lost its power, the opposers draw the limb in the opposite direction by virtue of that constant and elastic sort of force. For a long time after the commencement of the paralysis, there is nothing whatever wrong with the active muscles; but after they have been allowed to become thus short for a certain period, they begin to adapt themselves to the shortened condition, and still further contracting, as they meet with no resistance, determine at last changes of form in other structures, and so produce permanent deformity. The paralysis is by no means, however, as a rule, persistent; on the contrary, such affections occurring before the age of puberty, in the

absence of organic disease (as pressure on the spinal cord, tubercle in the brain, hydrocephalus), or of congenital deficiency (idiotcy or imbecility), are, as a rule, curable. Nevertheless, it is not to be imagined that when the limb has yielded in the direction of the healthy muscles, the sickly ones can recover sufficiently quickly, or entirely to restore, by their unassisted might, the proper balance of the foot. The weakened muscles still want assistance; and the way to render this in the manner, which shall best aid them to overcome the deformity, and to recover from their paralysed or enfeebled condition, is the problem, which surgery should endeavour to solve. Orthopædism having, as it appears to me, taken a point of view which has led into grievous errors of treatment, I have applied myself to the above inquiry, and believe that its true solution will be found in the following pages.

CHAPTER III.

ON THE IMPROPRIETY OF TENDON-CUTTING, AND ITS EVIL RESULTS.

The operation of cutting tendons or muscles had been haunting the domains of legitimate surgery for about one hundred and fifty years, and had been gradually becoming a less adventurous proceeding, when, in 1832, Stromeyer demonstrated a method of its performance without danger, or at least with very little danger, of producing suppuration and sloughing. No sooner, however, was this point established, than the operation was driven to the most unbounded exaggerations, under which it is still labouring. The imme-

diate results were apparently so brilliant, that at first the profession, then the public, were captivated by the procedure; no time has as yet been given to observe whether the prospects, which these first effects open to us, are fulfilled, nor whether other evils quite as bad or worse than the original deformity are produced by the operation.

A goodly number of club-footed patients come under notice with the paralysis still continuing, a good many with the muscles still excessively languid. The patient is in one of the following conditions: he either has too few muscles, or some of his muscles are too weak to act; and the so-called orthopædic practice of the present day is, unfortunately, to cut the tendons, and destroy the power of those organs which are still healthy. It is quite certain that if all the active tendons be divided, so that there be nothing to

resist any external force, the foot can be squeezed into something like shape; but to the annihilation of its power. That the above is not a misrepresentation of tenotomist treatment may be seen by the following: "Upon attempting to adduct the feet, the peronei and common extensor were rendered extremely tense; upon attempting to flex the foot, the tendo Achilles was also tense; and upon an attempt to depress them, the anterior tibial and extensor proprius pollicis were also tense, there being the smallest possible amount of motion in the ankle joint, and that of an unyielding character. I therefore proposed the division of the whole of these muscles."* Again, another writer says, "The peronei tendons are to be divided, or, together with them, those of the extensor longus digitorum and the tendo Achilles; and also those of the tibialis anticus and

* Tamplin on "Deformities," p. 77.

extensor proprius pollicis," after which the author adds, "there is considerable difficulty in continuing sufficient support to the arch of the foot, and even after the arch has been restored, support has to be continued for many months :"* and really it would be wonderful if such were not the case. We find also that varus is treated upon a similar plan, namely, that of dividing every tendon whose muscle still appears active enough to resist any force applied from without. For instance, the tendons cut are the tendo Achilles, tibialis posticus, flexor longus digitorum, and tibialis anticus. We might consider such divisions, even under ordinary circumstances, sufficiently severe ; but let us imagine it for a moment when most of the uncut muscles are paralysed, and we shall have to picture to ourselves the foot as an inert mass, hanging to the end of the leg like

* Brodhurst on "Club-foot," p. 122 and 124.

the swinger of a flail. This disabled member is then subjected to shoes, and screws, and straps, until it is forced into a shape which looks very fairly in a cast or a woodcut, of the "before and after" type of illustration; but in real life, and in the act of walking, the limb is a far less desirable member than it appears in effigy. If, however, the parts would as a rule recover themselves, and if the results of such extensive division of tendons would pass away, very little blame could be thrown on the operation; but the truth is, that we again and again see cases in which the only muscles having no power, that is, the only irrecoverably lame ones, are those that have been cut; or, what is not quite so bad, that neither the tenotomized muscles, nor the ones that had been paralysed, have any power over the limb (except perhaps the sural muscles), and it swings almost uncontrollably with

the walk, being sometimes put down on one side, sometimes on the other,—the toes generally being the only part that comes to the ground.

It has fallen to my lot, during a life of close observation, to see many cases of this sort; indeed, at the present time, I have two patients under my care, one of whom has been the subject of tendon-cutting treatment ever since his birth, ten years ago; the other not quite so long. Both have worn all sorts of irons and shoes for years, with the result of still further weakening the limb. They have neither of them the power of controlling the way in which the foot shall come to the ground, and the Achilles tendons are contracting in both, so that the deformity is being reproduced.

It is now high time that the advantages and disadvantages of tenotomy should be fairly scrutinized. We will begin with the tendo Achilles. The

excellent Prussian surgeon above named, who realized the safe method of dividing tendons under the skin, had made his first attempts on this part; and, as it happens, this is, of all tendons probably in the whole body, and certainly in the foot, that which lies most convenient to the knife of the surgeon, and most advantageously situated for reunion: it is isolated, lies close to the skin, and is surrounded by a quantity of loose cellular-tissue and fat. Thus, to produce a non-union of this tendon would require a diligent application of ignorant interference; and if it unite, as I believe it always does, to some of the neighbouring cellular-tissue, that material is so lax, that the adhesion is of slight or of no consequence. Nevertheless, we are not to imagine that the operation is necessarily productive of good results, or that it may not be followed by certain ill effects. It must be remembered that

the contraction has only taken place in consequence of deficient resistance. By dividing the tendon we annihilate all opposition to such contraction, but at the same time we prevent it affecting the foot. The muscle retracts and the calf shortens in the leg to the extent of an inch or rather more; but a uniting material forms between the two ends of the tendon. The tonic contraction of the muscle, however, still continues, and to this is now added the cicatrix-contraction at the wound, and, through the medium of the new material, these can again act on the foot. By the application of instruments, a return of the distortion may be prevented as long as the mechanisms can be worn, or until by their force they have stretched *the muscle* to the proper dimensions. In this latter case the tenotomy has had simply the following results: it has allowed the calf to shorten, and therefore produced of itself

a certain deformation and debility; it has not superseded by a single day the use of mechanical force, since, after all, the *muscle and not the tendon must be stretched.* The operation renders the first application of such force apparently more effective, since there is nothing to resist its power; but the work to be done is only postponed till complete union has taken place, and thus the tenotomy has entirely wasted all that time, which was employed in the repairs of the artificial injury. Under such circumstances, if the instruments cannot stretch the muscular fibre, but only prevent the return of the distortion, the patient will have been put in the unhappy position of those whose cases I mentioned in a former paragraph; that is to say, the muscles of the limb are either paralysed or have a greater tendency to contract than ever. There are a few very rare cases, and these chiefly from want of

development, in which we may be compelled to accept these ill consequences of dividing the tendo Achilles for the sake of some immediate advantage,* for the sural muscles are peculiarly placed, and if they be insufficiently developed, their shortened condition may be difficult to overcome. We have seen that this tendon is remarkably well situated for operation and repair; let us examine some others which are generally the subjects of division.

The tendons which pass in front of the ankle-joint are bound down tightly by a strong band of fibrous structure, which runs across them, and partially invests them; moreover, each is provided with a synovial sheath. Those, which lie behind the joint, run in grooves of the bone, wherein they are encased by very strong fibrous or ligamentous

* It will be seen when we speak of talipes equinus that these advantages are very much less than is usually imagined.

bands. There are two behind the inner ankle and two behind the outer ankle, running close together, and one, the flexor longus pollicis, between the two. Their situation, and the way that they have to pass under the ankle to get to the foot, causes them to press very tightly against the bone, and, to prevent their slipping out of the groove, the ligaments are strained firmly over them; lastly, they are provided with synovial membranes; in fact, the tendons lie in very tightly fitting tubes. When demonstrating anatomy at St. Thomas's Hospital ten years ago, I frequently shewed this disposition to the pupils, and would point out, that when such a living tube was wounded, and a tendon fitting it tightly was cut, how extremely unlikely it would be for the tendon to reunite without also uniting to the tube, either at the wound or elsewhere, and that if both tendons were cut they would adhere together.

I would here refer to four experiments on dogs performed and reported by M. Bouvier,* in 1842. He divided subcutaneously the *flexor carpi ulnaris* and *radialis*, the *flexor digitorum sublimis* and *profundus;* in one case all of them, generally two or three only; in no one instance did the subcutaneous wound unite so as to restore the use of the parts. In one experiment the two divided tendons did not unite at all; in another, all the severed structures were massed together, thus destroying their normal action; and in two, besides this latter condition, the new tissues bound the tendons firmly to the bone, so as utterly to annihilate all muscular action. This last event was found also in a horse, operated on by M. Bouley. Thus we have five experiments on animals in whom some tendon other than the Achilles was divided, with the result

* *Bulletin de l'Académie Royale*, t. viii., pp. 115—117.

in every case of destroying the action of the muscle.

It may, however, be easily affirmed that such experiments cannot be accepted as proof of what occurs in man; we will go a step further.

There has been for some time, raging among tenotomists, a difference of opinion concerning the mode, in which tendons were supposed to unite, and quantities of rabbits have fallen victims to the dispute; but the tendon chosen for the experiments was always the tendo Achilles. Anxious, however, to prove what appears to him the right view of the case, Mr. Adams has made it a point, whenever any tenotomized patient had died from other and fortuitous circumstances, to obtain leave for an examination of the parts. It is to be supposed that he found the facts, so obtained, support his idea of an intermediate uniting substance, since,

about two years ago, he published the series, together with his experiments.* I also found that these results fully supported my opinion, namely, that such tendons as those whose position I have above described, form union rather with the surrounding tissues than between their divided ends; which opinion has been greatly strengthened by the specimens, brought from time to time before the Pathological Society. Now, the cases of post-mortem examination in the book referred to, amount to twelve; in five of them the tendo Achilles only was divided, with which tendon we are not now dealing; there are therefore seven in which other tendons were divided, and I have made the following analysis of the results as to union, non-union, &c.

* *On the Reparative Process in Human Tendons.*

No. of Case.	Tendons Divided.	Results observed.	Time lived after Operation.
I.	Tendo Achilles ..... Tibialis anticus	Non-union of tibialis anticus	4 days.
II.	Tendo Achilles ..... Tibialis anticus ..... Tibialis posticus ..... Flexor longus digitorum	Non-union of tibialis posticus ..... Non-union of flexor longus digitorum	11 days.
III. Left	Tendo Achilles ..... Tibialis posticus	Tibialis posticus, adherent to the bone	23 days.
III. Right	Tendo Achilles ..... Tibialis anticus ..... Tibialis posticus.....	Tibialis posticus was supposed to be, but was not, divided	30 days.
IV.	Tibialis posticus ..... Flexor longus digitorum ..	Union to all surrounding parts..... No union ; held together by shreds of sheath, to which other tendons also adhered	18 days.
V.	Tendo Achilles ..... Tibialis anticus ..... Tibialis posticus ..... Flexor longus digitorum	Tibialis posticus and flexor longus digitorum adhered together and to the bone	6 weeks.
VI.	Tendo Achilles ..... Tibialis anticus ..... Tibialis posticus ..... Flexor longus digitorum	Tibialis posticus and flexor longus digitorum adhered together and to the bone. Ends of tibialis anticus hung together by shreds of sheath	6 weeks.
	In the five next cases in the work analysed the tendo Achilles only was divided.		
XII.	Tendo Achilles ..... Tibialis posticus..... Flexor longus digitorum	Non-union of tibialis posticus ..... Neither retraction nor extension of the flexor longus digitorum	Several years.

The result, therefore, of the cases is this, that out of six divisions of the anterior tibial tendon, we have two non-unions,* *i.e.*, in a third of the cases operated on, the muscle is destroyed. In every instance in which the posterior tibial tendon and the long flexor of the toes were divided, one or both, the action of the muscles was utterly annihilated, and, of course, that lameness and uncertainty of the foot above described must have followed. It happens that we have no case in which the peronei were divided, but as their position behind the fibula is precisely analogous to that of the others behind the tibia, there is no reason to doubt but that there would be exactly similar consequences.

Now, these are the only cases of post-mortem examination after tenotomy; (it has taken nearly ten years to get them

* From some of the descriptions it appears to me that adhesions were present in other of the cases, but as this is not clear I have not noted them.

together), their results are not only compatible with experiment, but perfectly such as we should reasonably expect from a consideration of the structure of the parts; and we can draw no other conclusion from them, but that such tendons as lie in sheaths close to bones, namely, the posterior tibial, the flexor of the toes, and the two peronei, might as well be struck by sudden and irremediable paralysis, as be subjected to the knife of the tenotomist; and that other tendons, those in front of the foot, are only a little better off in this particular.

There is no doubt but that tenotomists have felt this danger, and they have talked about avoiding it by dividing the tendons so high up the leg as not to implicate the sheaths. This, however, is an impossibility. That structure does not begin with a sharp, sudden edge; but is a part of the strong deep fascia

of the leg; which binds down the muscles themselves, and which gradually gets thicker as it descends. Thus it is not the mere bare tendons alone which are ensheathed; the posterior tibial muscle, for instance, although it forms its tendon pretty high up in the leg, continues to arise muscular from the bone till very near the malleolus. The long flexor of the toes ceases to be muscular a little higher, but below the point where it becomes encased in a sheath of fascia.

Therefore there is no place for dividing these tendons, so that they can reunite and retain their action; and thus although, as I have already remarked, the foot after such an operation may be squeezed into some approach to form, the limb is lame; it is indeed more hopelessly lamed than before the treatment. But I must make a still further observation on one of these cases,

namely, Case III. in the list. In the right foot of that unfortunate patient, an attempt had been made to divide the posterior tibial tendon, and the limb had come into shape so well that the tenotomist imagined he had been successful. On examination, however, after death, it was found that this tendon had not been divided. Now this event discloses a most extraordinary fact, namely, that these tendons are often so little resistant, that the orthopædists do not know by the after symptoms, whether they have been cut or not. That at all events in a certain large proportion of the cases, the feet would come into shape just as well without the infliction of such treatment.

CHAPTER IV.

THE MECHANICAL AND AFTER TREATMENT.

After division of the tendons according to the orthopædic fashion, the foot is fastened into a metal clog provided with screws, and a spring intended to press the limb into shape. At the present day these instruments are all founded on the same principle, taken from Scarpa's plan, although almost every orthopædist has a shoe of his own, in which he sees certain excellencies, absent in his neighbour's. Before Stromeyer ultimately established the immediate safety of subcutaneous tenotomy, shoes of some sort or another were used for the reduction

of club-feet, and with sufficient success to give to certain cleverer machinists or better manipulators than their fellows a wide celebrity. At the latter end of the last century, four specialists had such reputation, Jackson in England, Tiphaisne and Verdier in France, and Venel in Switzerland. They all kept their particular mechanism secret; but by means of a patient treated in the Swiss Institution, so much oozed out of Venel's machine, as to induce three Germans (Ehrenmann, Brückner, and Naumburg,) to make others in imitation. The essential principle seems to have consisted of an iron shoe or sole, at right angles to which was affixed a staff of the same metal. When the foot was firmly fastened to the former, the staff was gradually approached to the leg, so as to make the sole face directly downwards, there was also a mechanism for correcting the adduction of the foot.

I think there can be no doubt but that Scarpa took the plan and idea of his instrument from Naumburg's* and Brückner's† imitation of Venel's apparatus, and substituted a perpendicular spring for their upright staff, and a horizontal one for their mechanism to overcome adduction; an idea which, if we credit his friend Malfatti, he had obtained from Tiphaisne in a manner which in England is considered dishonest, namely, by bribing his housekeeper.‡ However this may be, Scarpa's shoe has become the mould, in which all other orthopædic instruments have been cast. It consisted of a shoe carrying a horizontal spring for exerting sideways pressure, and a perpendicular spring attached to its side, and strapped below the knee with more or less tightness,

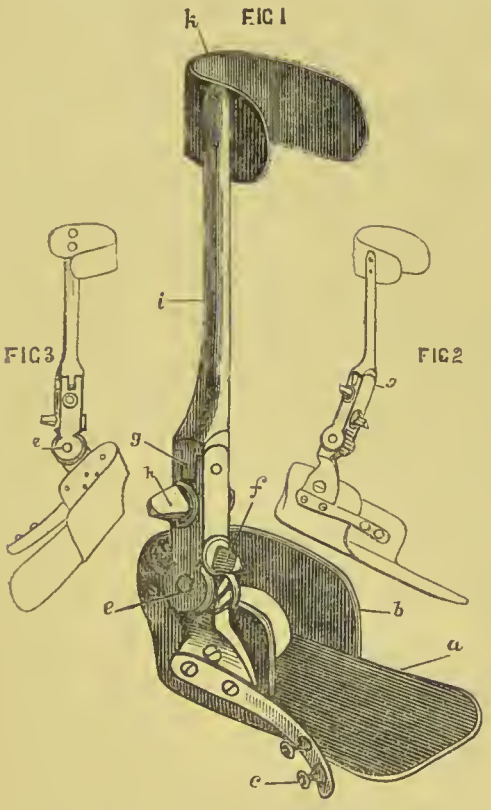
* Abhandlungen über Verkrümmungen, 1796.

† Ueber Einwärts gedrehte Füsse, 1798.

‡ See preface to Malfatti's German translation of Scarpa's work, "Sulle Piedi Torti," p. iii.

which was to twist the shoe and the foot on its long axis, and make the sole face downwards. A little alteration in this apparatus is made by substituting for spring power a screw force, which necessitates the more frequent attendance of the orthopædist with his key. The plate gives a sufficient idea of the steel groundwork of the machine before padding and straps are added. There is an iron sole the length of the foot, the heel being enclosed in a semicircular portion, which comes forward as far as the ankle bones, and serves for the attachment of the other parts. These are a horizontal spring to abduct the foot, and a perpendicular lever which is fastened above the middle of the leg by a semicircle of steel behind, and a padded strap in front. Now, a little above the place, where this lever is fastened to the foot portion of the implement, may be seen two screws with

triangular heads; the upper one screws the shoe, and with it of course the whole



THE IRON FOUNDATION OF AN ORTHOPÆDIC SHOE.

Fig. 1. The shoe in a straight position. *a*, The sole; *b*, the semicircular portion to embrace the heel, a portion being cut away, leaving a hole for the point to protrude; *c*, the horizontal spring for abduction of the foot; *e*, a hinge in the upright portion; *f*, a triangular screw-head, which is turned with a key, and causes the point of the instrument to turn down, as seen at Fig. 3; *g*, another hinge; *h*, a triangular screw-head, which, being turned with a key, bends the foot part outwards, as at Fig. 2; *i*, the upright staff; *k*, the semicircular part to go rouud the leg, and act as the fixed point of the apparatus.

foot outwards or inwards; the lower one turns them up or down in the direction of flexion or extension. Now, it needs only one glance at this instrument to see, that the whole of its rotating and flexing power are exercised on the ankle-joint; the same thing applies to those, in which a spring is substituted for the perpendicular staff.* However such implements may be varied, whether by retaining the original rod of Venel, or substituting the perpendicular spring of Scarpa, or making a joint work by a cog-wheel instead of a screw, &c. &c., they all are formed essentially of an unyielding sole, to which the child's foot is fastened, and then twisted round *as a whole.* It is not of any importance, as long as that principle is retained, whether screws or

* A dreadful defect in the instrument depicted is that the rotating and the flexing force are exerted in different parts of the perpendicular rod, and that one, perhaps both, must necessarily be false to the place where the human ankle bends.

springs be used; whether the spring be of steel, or of any other possible material.

After the tendons have been divided, the child's foot is fastened to an instrument of the above construction, and the screws are turned, or the spring tightened by degrees, twisting the ankle-joint more and more until the sole (or at least part of it) looks directly downwards. Let the reader consider our description of the medio-tarsal joint, of the manner in which the front of children's feet can be turned round upon that articulation, till the sole looks inwards, and can be adducted and flexed to a marvellous degree; let him also remember that every muscle except the tendo Achilles is inserted in front of that joint, which must therefore yield to all muscular action; and that to such action club-foot is due. Let him also examine a club-foot, a varus for instance, and he will very soon be

convinced, that the real deformity lies in the front of the foot; also that the change in position at the ankle-joint is secondary and comparatively slight. In fact, he will see that the front half of the foot is *rotated and adducted upon* the back portion; and that therefore to overcome such deformity the force must be applied to the anterior part of the limb. Therefore that any shoes, whether of Venel, Brückner, Scarpa, or others, having rigid soles, acting upon the foot *as a whole*, and not taking into consideration the twist in each portion of the limb, nor the position of muscles attached to each bone, are very ill adapted for the cure of club-foot, whose very essence lies in those hitherto unnoticed particulars.

But as the tendo Achilles is attached behind the medio-tarsal joint, indeed behind the ankle-joint altogether, as the foot might be supposed therefore

to act in extension and flexion as one mass, it might be considered advisable to treat by shoes, and *as a whole*, such deformities as equinus and calcaneus. We shall see at its time and place what is the real condition of equinus; but in the meantime let any one, who can imagine the foot a solid mass, carefully watch a barefooted man, woman, or child walking even slowly, let him try to imagine those elastic movements, which he will then perceive, increased into running, dancing, or leaping; then let him, if he can, imagine the desirability of treating the foot, *as a whole*, in an iron-soled shoe. There is yet another, perhaps even a more urgent reason why the treatment by such instruments is so unsatisfactory. The greater number of, if not all deformities are, we have seen, produced by debility or paralysis of certain muscles. Now, as soon as a muscle is thus circum-

stanced, everything which might aid fatty degeneration, ought to be avoided; for in youth by far the larger number of paralyses are curable, while such degeneration can be prevented. But orthopædic treatment appears especially designed to favour and hasten the advent and progress of this condition. The non-paralysed muscles are cut, ensuring to them the most complete loss of function, while the foot is fastened upon an iron plate in such wise as to prevent any movement of the sole, therefore all muscular action, and this confinement is enforced for six weeks or for as many months. Of course, when the foot is released, all the muscles will have been reduced to the last stage of debility, and the patient will be fortunate, if fatty degeneration have not advanced far enough to deprive him of the use even of those muscles, that have not been divided.

CHAPTER V.

MY NEW METHOD OF TREATMENT.

I HAVE devised and carried on to success a plan of treatment diametrically opposed to that by tenotomy, and utterly different to that by shoes. It is conceived and founded on the following principles.

1st. That as the loss of balance in muscular action, which produces the deformity, is nearly always caused by paralysis of a certain set of muscles, we are to restore that balance.

2nd. This restoration is to be accomplished by substituting a force for the

weakened or paralysed muscles, and not by depriving the still useful ones of their power.

3rd. That the succedaneum must be applied as nearly as possible in the direction and position of the paralysed organ or organs; and must act on the parts, and on those only, on which the muscular force is normally expended.

4th. Thus the foot is not to be treated as a whole, but as a compound of many bones; each of which being subject to muscular action plays a definite part in deformities.

5th. That since motion is essential to prevent or overcome fatty degeneration, as well as to allow the weakened muscles to recover their power, the foot is not to be fastened to any rigid clog; but, on the contrary, each part is to be allowed movement, which is gradually to be guided by the imitative force from an abnormal into the normal direction.

These principles, which are logical and physiological, had not been founded nor applied to the establishment of a new plan of treatment previous to Nov. 1861, at which time my paper entitled, "On Certain Grave Evils Resulting from Tenotomy, and on a New Method of Curing Deformities of the Foot," was read before the Medico-Chirurgical Society, and has since been printed in the "Transactions."* The means, which I adopted to carry out the problems set up, were to substitute for the absent or diminished forces a spring or springs of india-rubber, stretched between the origin and the insertion of the muscle, at a degree of tension that would supplement the weakened or supply the absent power of the organ. The insertion of the muscle was evidently to be imitated by adhesive plaister fixed over the place of attachment for the tendon. But there

* Vol. xlv. p. 25, *et seq.*

was great difficulty in imagining any mode of obtaining a fixed point upon the leg, which should imitate the origin of the muscle or muscles without causing constriction of the limb, until the plan shortly to be described was adopted.

It will be as well to give some notion of the amount of extensibility and of power which an india-rubber spring possesses. It can be stretched to six times its length without losing contractility; when extended further, the material yields. It appears capable of bearing extension within those limits for any indefinite length of time, and yet at the end to be nowise weaker; it is also able to support alternate extension and relaxation, however rapidly and frequently repeated, with but a small loss of power. I believe myself right in the details of an experiment, which was mentioned to me, but the narration is from memory. A gentleman had at

his works an engine, which was kept going night and day; he carefully measured an india-rubber spring, and fastened it to some part of the machine, which extended it to four times its length nineteen times in the minute; at the end of nine years it was found longer by one-twelfth only of its original length.

The mathematical formula for determining what amount of force is being exerted by the spring is this: let l = unstretched length of spring; l' = its stretched length; T = tension of spring; c = a constant, then

$$l' = l\left(1 + \frac{T}{l}\right) \therefore T = c\left(\frac{l'-l}{l}\right)$$

If a be the length of the string when 1 lb. is hung on it, then

$$1 = c\left(\frac{a-l}{l}\right) \therefore T = \frac{l'-l}{a-l}$$

That is to say, extension in general, *i.e.*, the additional length to which the spring may be pulled in any one individual

case, divided by the additional length produced when a 1 lb. weight is hung on it, will give the number of pounds pressure, which the cord is exercising in the particular case. Suppose we find that 1 lb. adds $\frac{1}{4}$ inch length to the cord, if at any time it be stretched an inch, a force of 4 lbs. is being exerted; if it be stretched 4 inches, 16 lbs., and so on. I have all my springs made of the same sized cord, and of certain definite lengths. Knowing the strength of the cord, I can immediately tell what force is exerted by any spring. We will not longer consider the application of this method in general; but will pass on to describe the treatment of different deformities, beginning with the simplest.

CHAPTER VI.

FLAT FOOT.

FLAT FOOT is a commoner deformity among the poor than the wealthy; among the lymphatic and melancholy than among the sanguine temperaments. There are, however, a good many persons in the middle and upper classes with a tendency to this malady, who, when getting into years, or suffering from general debility, feel its peculiar ill effects, namely, a want of flexibility and power in the limb; they complain, in fact, of getting whole-footed, and more especially of a severe pain at the inner side of the arch of the foot in the situa-

tion of the navicular. This pain, which generally increases as the case goes on, becoming at last very severe, is usually

FLAT FOOT SEEN FROM THE FRONT.

The twist inwards of the anterior half of the foot, and the giving way of the instep, are well shown.

ascribed to the tightness of the plantar fascia through flattening out of the arch. It is curious that anatomists with the

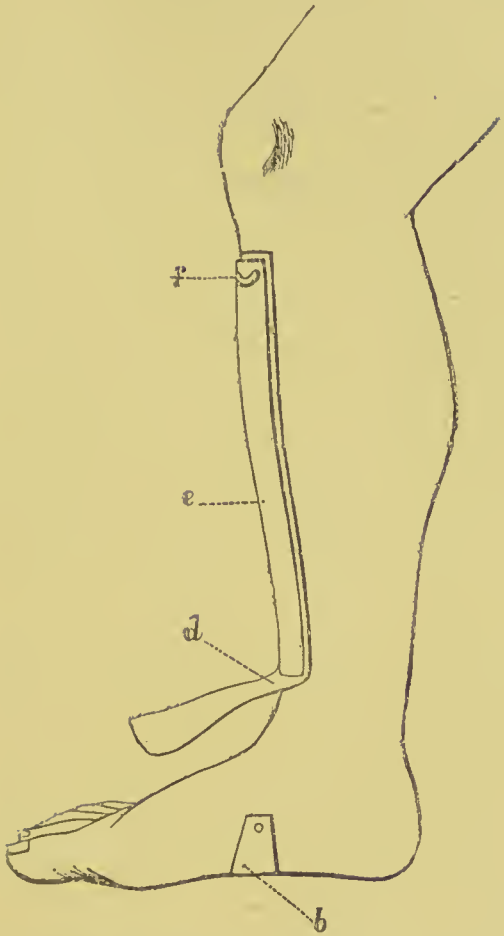
same breath attribute to that fascia the duty of keeping up the arch of the foot. If the plantar fascia keep up the pedal arch, it must always be on the stretch, without the production of pain, and if it fail to do its duty, and let the sole become flat, there would be absolutely less tension, and therefore less of such cause for pain. But the fact is, the sinking of the plantar arch depends on debility of the anterior tibial muscle, the pain is caused by unaccustomed parts coming to the ground; and more particularly by the scaphoid and inner cuneiform falling sufficiently low to compress between themselves and the ground the large internal plantar nerve, just at its subdivision. Another office of this muscle is to keep the foot in such position upon the ankle-joint as to cause the weight to fall rather on the outer side of the sole. This part of its action is antagonized by one of the duties of the peroneus longus.

Thus, when the anterior tibial fails, there follows a certain amount of outward rotation, that is, an approach to the valgous condition, furnishing a further proof of the truth of my assertion concerning the action of this muscle.

Now it is evident, that both these malpostures, being produced by one deficiency, are to be remedied by supplying that deficiency; namely, by some force imitative of the anterior tibial muscle. First, a trapezoid piece of plaister* is made to adhere with its broader portion to the inner side of the sole of the foot over the cuneiform and head of the first metatarsal bone, and extending beyond their outer edge, even to the outer side of the foot. The direction of this plaister must be the same as the internal

* It must be understood that the plaister used is to be the emplastrum resinæ, spread upon a strong twilled calico, and all strips from it must be cut *lengthwise*, the irregular-shaped pieces as much so as possible.

PLATE IV.



COMMENCEMENT OF THE APPLICATION FOR FLAT FOOT.

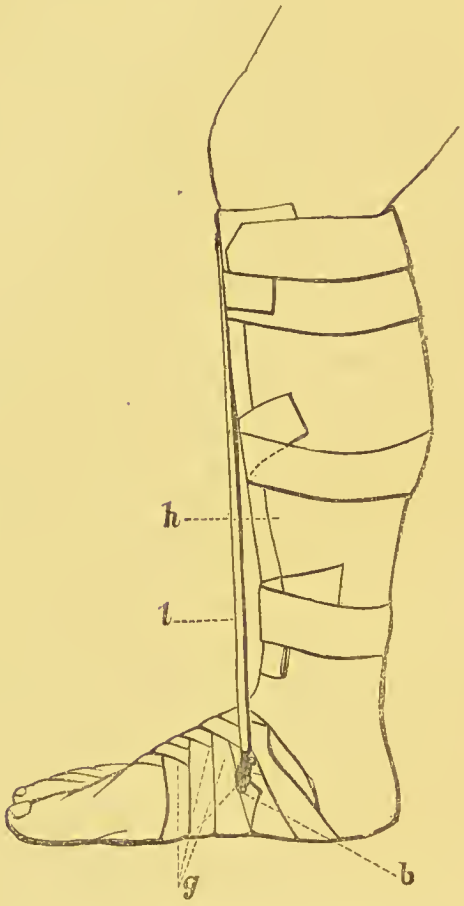
b, A trapezoid piece of plaster into which an eyelet has been fixed, adhering to the sole of the foot, to act as the insertion of tibialis anticus tendon; *d*, a strip of strapping adherent over the anterior tibial muscle (it is represented too straight along the bone), and having its lower end hanging down more than the length of the limb; *c*, a piece of tin carrying a wire loop (*f*).

tibial tendon, the narrower part should terminate upon the inside of the foot, just in front of the inner malleolus. This end is not to adhere to the skin; but is to be doubled down, sticky sides together, and through the twofold thickness an eyelet is to be driven. (Pl. IV. *b*.) The foot is now to be held by an assistant as nearly as possible in the proper position, and to be evenly strapped from before backward, leaving out the end of plaister, into which the eyelet was driven.

We now turn to the leg. A piece of strapping, from three-quarters of an inch to an inch broad, not quite three times as long as the distance from below the knee to the ankle, is made to stick firmly over the course of the anterior tibial muscle, upon whose origin one of the ends lies, the other hanging loose below the foot. The surgeon must be provided with a piece of tin rather narrower

than the long piece of strapping, and long enough to reach from the tuberosity of the tibia to a short distance above the ankle-joint. This tin by means of two holes in its upper part supports a wire loop, and it is to be bent into a concave shape, and be twisted a little so as to fit roughly over the surface of the muscle. It is safer to give the lower end a little inclination outwards, so that any force, subsequently to be exerted, may not press its edge against the shin. The piece of tin is to be laid upon the strapping, whose lower end is to be turned up over the metal, and held there while the leg is carefully strapped from below upwards. At the top of the tin a hole must be made in the strapping to permit the wire loop to come through, and I must caution the surgeon that it is necessary to fasten down with the strapping the little end of tin, which extends beyond the loop. There remains an additional

PLATE V.



AN ADVANCED STAGE IN THE TREATMENT OF FLAT FOOT.

The longitudinal pieee of plaister has been turued up over the lower end of the tin, and four eircular pieces of plaister have been put on the leg. Iu the ordiuary course the leg would have been covered, but it is here left partially bare, to show the position of the tiu and strapping. *g*, strips of plaister surrouuding the foot, but leaviug out the end of *b*, with its eyelet hole ; *l*, an india-rubber spring, running from the wire loop to the eyelet-hole.

length of the longitudinal piece of plaister now lying above the rest of the appliance; this may be brought down, and for more security made to lie on the outside of the circular strips. It will be perceived that the longitudinal piece of strapping is arranged in certain folds as follows:—It first adheres to the skin of the leg, then turning upwards forms a loop round the lower end of the tin, running up with its sticky side outward, and adherent to the inner surface of the circular strips, it thence turns round over the last transverse piece, and is brought down on the outside. By this means we have established at the upper part of the leg, on the origin of the muscle to be supplied, a fixed point—the wire eye supported through the medium of the tin by a loop of plaister, which takes its bearing in such a manner that no constriction of the limb can be produced, whatever downward

force be exerted on the wire. Now it only remains to stretch between the wire loop and the eyelet in the piece of plaister representing the insertion of the tendon, an india-rubber spring of such length as shall sufficiently supply the muscle without producing undue pressure.

I have had great difficulty in procuring springs of the form that seemed to me best. Those which I employed at first were of my own construction, but, as my use for them increased, it became impossible to waste time in such an employment. At last Mr. Hodges, of Bedford Row, made to my order half a gross of springs, of $\frac{1}{4}$-inch cord, of different lengths, the india-rubber being bound and formed at either end into a loop. Any whitesmith will make a few S shaped hooks of rather thin steel wire,* both ends of which are to be

* Pinion-wire-gauge about 57.

so curved that they will fit the bound part of the spring. In using the apparatus, I first put a bit of thin india-rubber tube over the loop of the spring, then fix the wire upon the latter; subsequently, when the whole is applied in its place on the leg, I draw the india-rubber tube over the hook, thus keeping it from slipping away, and protecting the dress or any part of the body from being scratched or torn by the points. I need now only remind the surgeon how very desirable it is not to begin too violently, and also that he must put on the plaister as smoothly as possible; any folds in the part, for instance, that represents the insertion of the tendon, would cut into the skin, and necessitate interruption of the treatment.

If, however, the application have been well managed, patients with this sort of deformity will experience immediate

relief, and those who limp into the room will walk out again upright and with ease. Of course the malady is not thus instantly cured; the use of the apparatus must be continued for some little time, and a shorter spring must be substituted in a week or ten days. The general health must be attended to. Iron, quinine, or other tonics, generous diet, cold bathing, &c., are to be enforced. As the muscle gains strength, it naturally shortens itself to the improved position in which the india-rubber keeps the foot. The sole regains more and more its normal curve, and though at first the arch will fall again when the appliance is removed, and the patient throws his weight upon the limb, yet in about a month it acquires sufficient power to support the body without yielding.

The length of time which may be necessary for the cure of this deformity

depends very much on the state of the general health as well as upon the local conditions. Unless, however, there be some weakening drain upon the system, irredeemably vicious habits, or constitutional cachexia, three months should suffice to overcome the malposture in the adult, less time in the young subject, rather more in the old. When the origin of the disease is abrupt, occurring about the time of puberty, generally as the body is assuming an over-rapid growth, and is considerably debilitated, the conditions of absolute cure are somewhat different. As long as debility remains, it is not safe to leave the patient without some support, even although immediately after removal of the appliance the foot may remain perfectly symmetrical; for under such unfavourable circumstances a relapse is likely to occur. If, however, the foot be reduced to its normal form, and, by

means of treatment or otherwise, strength have been restored, the apparatus may be discontinued, even although it have been employed for only a few weeks. In these debilitated cases the treatment saves much suffering, and often prevents permanent lameness, or at least awkwardness of gait.

CHAPTER VII.

TALIPES VALGUS.

Although other distortions of the foot may appear greater and as produced by more complete alteration in the position of parts, yet none is so painful and none more laming than talipes valgus. It is caused by paralysis, partial or complete, of the anterior and posterior tibial muscles. The action of the former has been already explained as that of keeping up the arch of the foot and of outward rotation. The action of the latter is extremely complicated, varying with the position of the limb at the moment. First, let us trace its influence on the

whole foot at the ankle-joint. When this is at right angles with the leg, the muscle has no power as either a flexor or extensor; it only acts as an adductor. When the foot is pointed, the muscle produces more powerful extension. When, on the contrary, the position is already flexion, then contraction of the muscle still further increases that posture. These effects of the muscle may be called forced actions. Its usual employment is adducting and rotating inward the anterior foot. It must be remembered that the ordinary tonic contraction of muscles is exactly balanced by that of other muscles; thus, even when no motion is produced, the organs are constantly acting, and by their mutual antagonism upholding the stability of the foot. Again, no muscle meets another so exactly as to neutralize its effects; on the contrary, one action of a muscle is resisted by portions of the powers of

two or more other muscles, the further phases of whose action is again opposed by a third set, and so on. Thus some portion of the power of the posterior is antagonized by the anterior tibial; but then these two are capable of combination for very powerful acts, while the muscles that chiefly oppose their combined force are the peronei. Therefore when the anterior and posterior tibials are paralysed or weakened, the peronei muscles being no longer, or too slightly opposed, drag the foot outwards.

The manner, in which the tendon of the peroneus longus lies across the sole, near the bases of the metatarsal bones, gives that muscle an enormous advantage over the limb in the direction of outward rotation; the position of the peroneus brevis, in that of abduction.* The outside of the foot is, however, as we

* We will not speak of the peroneus tertius in this place.

have seen (p. 8), so constructed as to be much firmer and less yielding than the inner side. Thus we never find such a twist and bend of the foot on itself outward as is produced in the contrary direction by another deformity—varus, in which the outer muscles are weakened. From this very cause, namely, the comparatively unyielding condition of the outside of the foot, the dominating power acts more directly on the ankle-joint itself, and thus the astragalus is turned sideways between the tibia and fibula much more than in a greater apparent deformity in the contrary direction. Hence is valgus so painful an affection; hence also the knee is apt to yield and fall inwards, the leg running in an outward direction, as if endeavouring to make the axis of the astragalus and tibia correspond. Another reason of the pain is the pressure on the plantar nerves, which I have already pointed

out to be a source of such discomfort in flat foot.

This deformity, which is not so common as the two next to be mentioned, is both congenital and acquired; when the latter, it may arise suddenly after infantile convulsions, or more slowly at a later age, when we may trace its gradual development. At first it makes its appearance as a little unusual turning out of the foot in walking, then the part appears to get broader, and is put down and lifted again in a lumpish, whole-footed manner; it soon grows broader, becoming a splay-foot, subsequently a flat foot, while the toes turn out more and more; and shortly after it will be observed, that the patient places only its inner side on the ground, the outer being lifted away. When the malposture is fully established, the foot is much abducted; it is also rotated outwards, chiefly at the medio-tarsal, partly at the

ankle-joint; the outer malleolus is less, while the parts below it are more protuberant than natural. The projection of the inner malleolus is unnaturally strongly marked. When viewed from behind, the tendo Achilles will be seen

PLATE VI.

AN ACQUIRED VALGUS.

The posterior tibial muscle is quite paralysed; the anterior has some power remaining, but not enough to keep up unassisted the arch of the foot; the stretching of the muscle produced by the falling in of the tarsal bones causes the tendon to project.

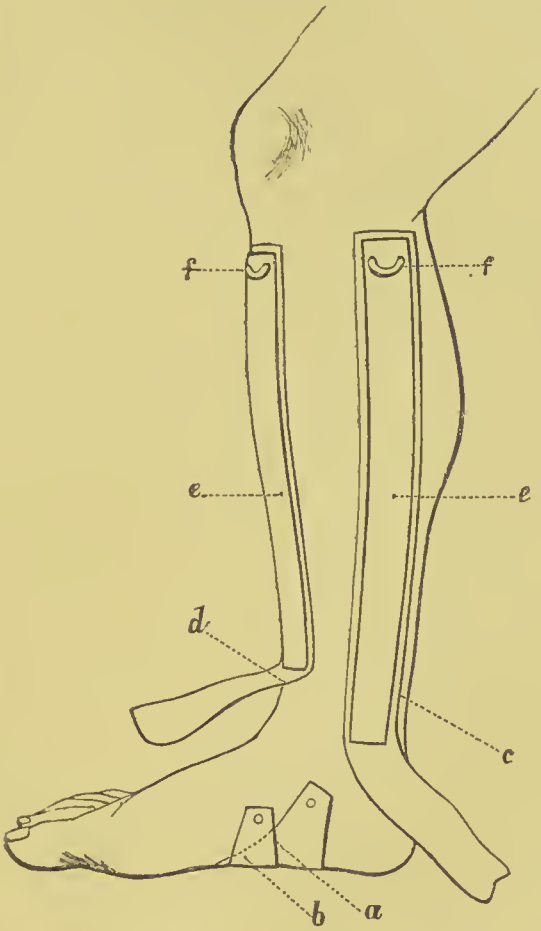
to have acquired a curve, the concavity looking outwards. Normally the foot itself ought to have an inflexion inwards, the outer side being convex, the inner concave. In valgus, these curves are nearly or quite obliterated, the two sides being straightened. They may be even reversed, the outer side becoming a little hollow, the inner bulging. The patient walks quite on the inside of the foot, the outer edge looking even somewhat upwards; in the most advanced and rare form of cases the inner ankle approaches the ground.

It will be found stated in orthopædists' books upon club-feet, that this deformity is due to unnatural elongation of the ligaments of the sole. I have already had occasion to demonstrate the fallacy of the notion, that the conservancy of such an active, light, and powerful mechanism as the foot could be entrusted to ligaments, which are only intended to act as occa-

sional aids to muscular force and as checks in sudden movement. When the contractile power of the muscles diminishes or vanishes, the ligaments offer no noteworthy resistance to change of form; thus the elongation and other alterations of these structures, always present in cases of deformity, are merely secondary, and, when position is restored, the fibres recover as easily as they yield.

The one rational indication of treatment is therefore to endeavour to restore the posture by supplying force in the place of the power whose absence produced the deformity. On the other hand, nothing can possibly strike the observer with more astonishment than to perceive that orthopædists divide, among others, the anterior tibial tendon (p. 28), for this is evidently one of the muscles to whose weakness the deformity is owing, and upon whose returning strength we must rely for the permanent restoration

PLATE VII.

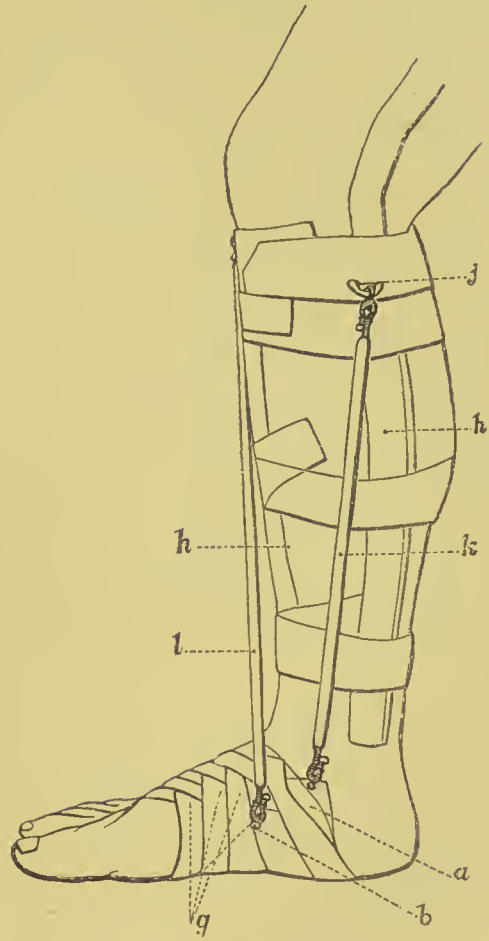


THE FIRST STEPS IN THE TREATMENT OF VALGUS.

a, A trapezoid piece of plaister, with an eyelet in its upper end, adherent to the foot in the position of the tibialis posticus tendon; *b*, a similar piece, adherent to the foot over the former, to supply the place of the tibialis anticus tendon; *c*, a broad and long piece of strapping adhering over the tibialis posticus muscle. The rest, nearly twice the length of the limb, hangs freely down; *d*, a similar piece of strapping, applied in a like manner over the tibialis anticus muscle; *e*, *e*, pieces of tinned iron laid upon the strapping at *c* and *d*, and roughly moulded to fit the surface; *f*, *f*, wire loops fixed in the upper part of each piece of tin.

of position. During the absence of its power, its place must be supplied by india-rubber springs, as also must the action of the posterior tibial. I have already described the mode and manner in which the substitute for the anterior tibial is to be applied; to this is to be added a somewhat similar apparatus for the posterior tibial. The longitudinal strip of plaister must be placed along the posterior edge of the tibia, and the tin which is laid on it, is to be more carefully bent to fit the surface of the limb, since the curves in this part are greater and more various. Moreover, since the somewhat crooked course on the foot of the plaister imitating the tendon would tend to pull the piece of tin awry, an additional security may be thus procured: before the metal is placed in its position, it is passed into two slits (corresponding accurately with its breadth), each one of which is cut

PLATE VIII.



AN ADVANCED STAGE IN THE TREATMENT OF VALGUS.

Circular strapping has been applied to the foot, and in part to the leg ; but only three such strips are shown in the diagram, that the arrangements may not be concealed. *g*, circular strips of plaister on the foot; *h*, *h*, arrangement of the longitudinal strips, the ends which hung loose in Fig. VII. are now turned up, and lie on the tin, sticky sides outwards; *k*, india-rubber spring to represent posterior tibial ; *l* india-rubber spring to represent anterior tibial.

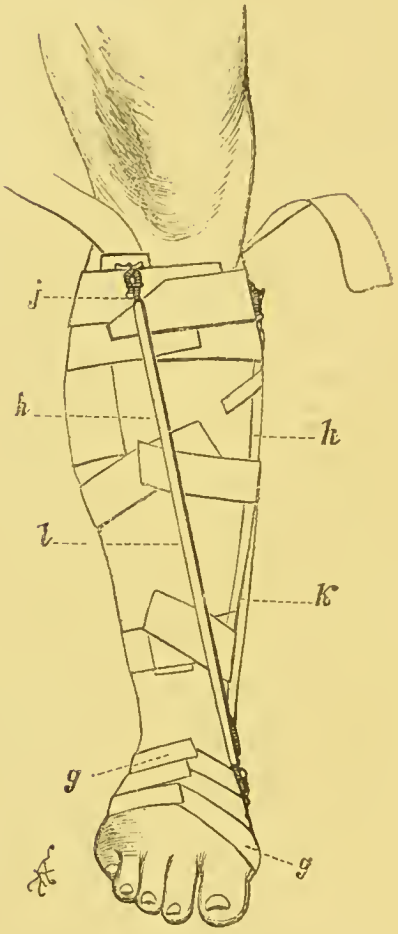
lengthwise in the middle of a piece of plaister that is long enough to go round the leg. The tin having been fitted into these slits, is to be so arranged, that one piece of plaister lies near the top, the other near the bottom; it is then to be put in its place, the strips are to pass round the limb adhering to the skin, and the whole leg is to be strapped as already described. By these means the metal is firmly fixed to the leg, and no power, which it would be possible to employ, could cause it to slip or alter its position.

The piece of strapping upon the foot which represents the insertion of the muscle, requires very careful arrangement. The principal tendon runs forward, and a little more downward, than a line drawn from the bottom of the inner malleolus to the ball of the great toe; it is inserted into the inferior aspect of the scaphoid, and of the internal

cuneiform bone; this part of the tendon is very thick and strong, and there run from it several slips, one across the foot to the outer cuneiform, another to the fourth metatarsal bone, and one piece turns back to the os calcis. Thus, a peculiarly broad attachment must be imitated, and the plaister, which should always be larger than the mere attachment of the tendon, is to be cut to that irregular rhomboid form which will best represent the shape of the insertion; the acutest angle is to be truncated, the plaister turned down, and this part suffered to lie on the side of the foot below the inner ankle.

The best plan, for regulating the direction of the force along the plaister, is to leave the truncated angle sufficiently broad to give some choice as to where the india-rubber is to be fixed, then to pull with the fingers in the direction of the spring, but at different

PLATE IX.



AN ADVANCED STAGE IN THE TREATMENT OF VALGUS (SEEN FROM THE FRONT).

The superfluous ends of the longitudinal pieces of plaister project on each side of the knee; the lettering is identical.

parts of the turned down edge, in order to find, where the force can be so placed as to be directed chiefly, but by no means entirely, along the anterior edge; and there the eyelet must be fixed. Moreover, the plaister is to be cut in such manner, that this anterior edge runs lengthwise along the threads of the calico; thus it will not yield, and is firmer than when formed in any other manner. Every woman at all accustomed to needlework or to "cutting out" knows the object of shaping certain parts "on the straight."

The next point is the selection of springs of proper length: this is a matter in which experience soon directs us to make an almost unerring choice; but the following rules may be taken as guides: never to put on too short a spring at first; to select, as a rule, the stronger and the shorter spring for the stronger muscle. When, as in this case,

there are two springs to be applied, the stronger one should be put on first, but its effect must not be estimated until both have been for some time *in situ*, when the position may be examined. We are not to expect that the posture will be entirely corrected at once; power sufficient to do this would be utterly unbearable; but the correction of one part of the deformity should be proportional to that of the other: a little experience in the treatment of these cases soon teaches the recognition of this relative correction. To aid his judgment, the surgeon should in every case, after the springs have been on for some time, pull a little upward upon the one, that seems not sufficiently to correct its part of the deformity, a little downwards upon the other, until he finds, wherein any possible error chiefly lies.

It will in all probability be desirable

to renew the whole application in about ten days or a fortnight; but it may be advisable to change that on the foot sooner, since the constant drag on the insertion plaisters has a tendency to loosen them; but they ought certainly to remain on a week. At the end of that time a considerable change will have taken place in the form of the foot, and it will probably be evident that on the next dressing one of the forces must be relatively increased and one diminished. This is always extremely easy, but the same care must be again taken in fixing the place for applying the force, and in judging their proper relation.

Some difference exists in the form of valgous feet, according as the peronei assume almost the entire governance of the limb, or as the sural muscles act more or less powerfully upon it, and this variation has given rise to the name of *equino-valgus* for the latter condition. It

is a matter of very little importance in a practical view, whether or no a little drawing up of the os calcis be present. The trial with the fingers as to the best place to fix the spring on the piece of plaister, which represents the insertion of the posterior tibial tendon, will show that in these cases the form is better restored when the force is applied rather further back, than in the non-extended variety.

If the patient be of age to walk, it is desirable from the first not to keep him in bed. Our hopes of a permanent cure without any lameness depend upon the muscles regaining such power as to act sufficiently strongly, to retain of themselves the foot in its proper place. The paralysis in children does not continue total for any great length of time, but the muscle is very much weakened, and it is only by exercise that its strength can be restored.

Fatty degeneration is the common

cause why children's limbs that have been paralysed do not regain their power, and here again exercise is most important; but if the limb be confined in a stiff shoe, which of course prevents the action of the muscles passing to the sole, all such salutary influence is entirely prevented.

CHAPTER VIII.

TALIPES VARUS.

This deformity, which is the direct contrary to valgus, is also much more common; its cause is paralysis of the peronei muscles. Now the peroneus longus, which runs across the sole of the foot, has a very great power of outward rotation, and of abduction; the peroneus brevis, being inserted in the outer metatarsal bone a good deal beyond the outermost line of the tarsal bones, gains a great mechanical advantage in abduction. Their constant action (tonic contraction), even while at rest, is necessary to keep the normal curved line along

the outer side of the foot, and to cause the sole to face downwards. We saw in our last section what their unresisted action can produce. If, on the contrary, their power be abolished, their antagonists assume ascendency, namely, the anterior and posterior tibial muscles gain complete mastery over the front part of the foot. The action of these muscles has already been explained sufficiently to show, that the result must be adduction and rotation inwards. Be it remembered, however, that all these tendons are inserted in front of the medio-tarsal joint, and that their actions are therefore primarily and principally expended upon the part of the foot which lies anterior to that important articulation; and also that these tendons are fixed at the inner side, the most movable part of the joint.

Varus may be either congenital or non-congenital. As the former, it is the

most frequent of all inborn deformities; but there is a vast difference in the amount and inveteracy of the malposture in different new-born babes; some having so little, that a twist of the accoucheur's hand replaces the foot, and a bandage keeps it in position; others have terribly distorted and obtruncate feet. Much of this difference depends upon the earlier or later period of intra-uterine life, at which the deformity commenced;* and even in acquired cases, the age of the malposture has much influence on its intensity, as well as on its curability or incurability, without any remaining lameness. There are certain indications, whereby we can accurately judge in each case how far we shall be able to restore a limb thus distorted; these will be better understood, when the deformity itself has been fully described.

* Somewhat, perhaps, upon the length of time during which the causational paralysis lasted; for such state may be recovered from, weeks before birth.

A distinction has been made between direct varus and equino-varus, according as the heel is not or is raised; the latter produces a somewhat more severe looking distortion; but in a practical point of view the difference is slight, and not worth, in my opinion, the amount of definition that has been expended upon it. My description shall be taken from equino-varus, as it is the more common deformity of the two.*

The peronei muscles (the weakened ones), and their antagonists being inserted in the front part of the foot, it follows that the unresisted force of the latter is exerted on that portion of the limb, which lies anterior to the medio-tarsal joint. The primary and principal alteration is adduction and inward rotation of the anterior upon the posterior part of the foot; but as the two displace-

* Other varieties have been made, namely, calcaneo-varus, and even varus-valgus: these are of excessively rare and even of doubtful occurrence.

ments occur together, it follows that since inward rotation causes the inner side of the foot to look upward, adduction takes place in the upward as well as the inward direction; and since adduction turns the inside of the foot backwards, rotation causes the sole to look backwards rather than inwards. Thus the toes are turned inwards and sideways, the big toe lying above and often quite close to the edge of the tibia, the little one underneath; and in accordance with the doctrine of the composition of forces, the internal cuneiform bone is drawn towards the lower anterior angle of the malleolus. Hence there is a sharp bend of almost a right angle in the inner side of the foot, while on the outer side is a salient angle of a few more degrees. The front half of the foot is also flexed, *i.e.*, the sole made more hollow. Thus three forced positions of the front half on the back half of the foot are estab-

lished, *viz.*, turning inward and upwards of the toes, twisting inward and backward of the sole, and bending of the sole.

PLATE X.

VARUS OF THE LEFT FOOT VIEWED FROM BEHIND.

The slight twist of the heel in relation to the inward rotation of the front of the foot is well seen; yet the heel is somewhat turned inward so that the patient walks a little on the outer edge, and this has rendered the part shapeless and dumpling-like; in many cases the great toe lies closer to the leg.

By this forced posture the medio-tarsal joint becomes partially dislocated, so that one may feel the head of the astra-

galus prominent and uncovered by the scaphoid; also at the outer side the edge of the os calcis, from which the cuboid has been dragged.

Although the medio-tarsal joint is in children exceedingly free, as I have already explained (p. 8); it nevertheless must happen that a position so forced will through the ligaments exercise some force on the back part of the foot, and tend to rotate the astragalus inward on the tibia.

We have already seen, that the construction of the ankle-joint permits very slight lateral movement; but if the deformity have commenced in early intra-uterine life, the pressure exercised by the tendency to rotation will mould the bones into a morbid form. Such cases uncombined with some deficiency of the nervous system are rare; but a considerable amount even of osteal malformation can be overcome, provided

the treatment be undertaken early, while the parts are still soft and cartilaginous; more particularly if the patient have not been allowed to walk, and by the weight of the body to press the bones more out of shape, than they could be deformed by the unassisted muscles.

Although the ankle-joint only permits a slight lateral twist, that amount is enough to render extension and flexion difficult, and to cause such an inclination in the astragalus and os calcis that the axis of the tendo Achilles becomes curved, the concavity looking inward. The action of the sural muscles, therefore, is no longer that of drawing the heel merely upwards, that is, of extending the foot; but it now also pulls the heel inwards, approximating what ought to be its inner side to the tibia, *i.e.*, to that very spot whither the inner side of the front of the foot has been dragged by other muscles; thus causing the heel

and the great toe to approach each other.

The effect of all these displacements is to bend the foot sharply in the middle, so that what ought to be the inside is very hollow, the outside angular; and to twist the limb laterally, so that the depressed angle looks upwards, and the salient angle which should be outside, is below; that the sole looks backwards (perhaps even a little upwards), the dorsum of the foot forwards (perhaps a little downwards). The toes are inside and turned, so that the great one lies close to the tibia; the heel also being less distant than it should be from that bone. Thus the inner malleolus is quite concealed near the angle of the foot, aud the outer one so very prominent, that when the patient walks, as he will do, on the angle at the outer (now lower) side of the foot, that bone nearly comes to the ground.

We should always be able to give the patient, or the parents of a patient, some account of the probable prospects of cure, the duration of the treatment, and the absence of, or the amount of lameness that will be left behind. No degree of muscular contraction, and therefore no degree of distortion, negatives in the least an entire restoration of shape and function to the limb. The age of the deformity, and more particularly the state of the paralysed muscles, must be taken into account. If muscles be still entirely paralysed, and if such condition have continued for many months or years, we can, of course, give little hope of re-establishment of function; but I would strongly recommend the enunciation of no decidedly unfavourable opinion until the muscle be carefully subjected to Faradization after the method of Duchenne, and as now generally used. So long as electric irritability remains in the

muscle, so long may we entertain hopes of its functional restoration; when irritability is quite absent there is far less, still some hope of re-establishing the contractility. The paralysis, total or otherwise, influences in no way our ability of restoring the limb to shape, it only affects, though not so unfavourably as tenotomy, its subsequent power.

We must be guided in our judgment concerning perfect restoration of form by the amount of change in shape which the bones may have undergone. Even in a newly-born infant the disease may have begun so early in his development, that very much change is produced; and, of course, persons who have been walking on their crooked feet for years will have their bones much altered in form. The bone, whose condition above all others is important, is the astragalus; in the first place its position in the ankle-

joint; secondly, the shape of its head. To decide these points the surgeon must grasp the front of the foot in one hand, and twist it by a gentle effort outward, judging by eye and finger whether this action alter the position in the ankle-joint, whether it change the oblique condition of the heel; then let him examine, if while thus held outward, extension and flexion of the ankle-joint become markedly freer: if so, he need not fear, that any changes in that joint will set limits to his success. The head of the astragalus, which is almost left bare by the displacement of the navicular, should be felt beneath the skin, in shape rounded and prominent to a degree proportionate to the amount of displacement. Experience gives to the surgeon's fingers an instinct of this relation, which, if he find correct, may assure him that there is nothing in that part of the foot to counteract his efforts.

But if, in spite of considerable deformity, he find the head of the bone dwindled and stunted, he will hardly hope to effect perfect restoration of the limb. Let him not, however, be precipitate; he must abduct and rotate outward the front of the foot, bringing it towards its natural position, as far as can be done without force; if the scaphoid slide up, and, without either grating or jerking, approach its normal position, leaving no indentation behind it, the change of form in the astragalus will be of less consequence, and if the subject be young, will probably recover itself very considerably. Thus a small amount of atrophy in this portion of bone is not an absolute bar to perfect restoration; but the reduction of the head of the astragalus to a mere tubercle is a very serious impediment. The alteration in this part of the foot may be taken as a very trustworthy

index of the changes in the outer side. We have already pointed out, that the adduction of the foot produces an angular gap between the os calcis and the cuboid, which has a tendency to become filled up by new material, preventing, like a wedge in a split tree, the return to normal posture. The amount of this filling up is always proportionate to the changes in the other bones above described.

The tendon-cutting treatment of varus is founded upon the system of restoring balance, between the paralysed muscles and their opponents, by paralysing the latter also. The tendons divided are nearly always four; the *tendo Achilles*, *tibialis anticus*, *tibialis posticus*, and *flexor longus digitorum*. If the artificial paralysis were a temporary evil, we could only say that its infliction is the best means of promoting fatty degeneration, but the table at p. 40 shows that except in the

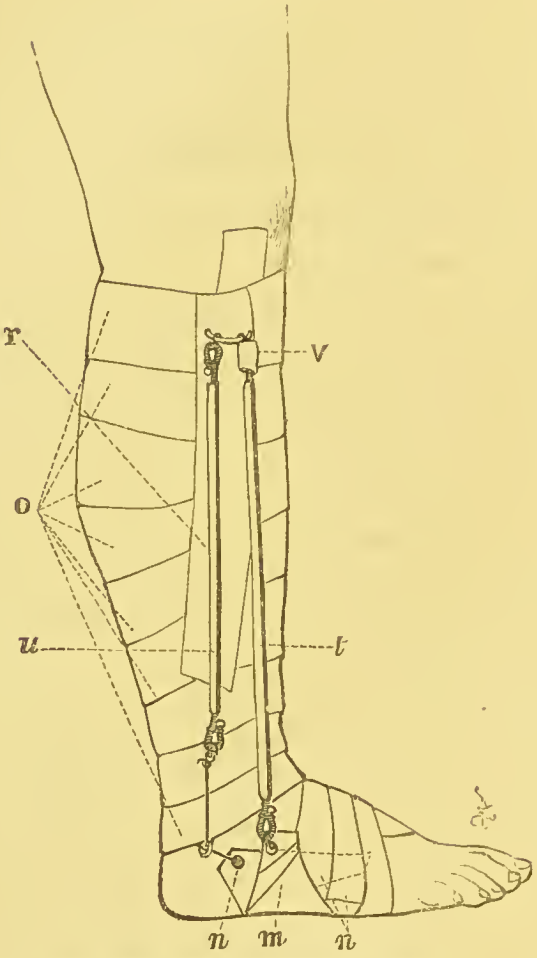
muscle of the first named tendon, the paralysis is lasting.

The action of the anterior tibial is permanently destroyed about once in three times, that of the others is always annihilated by the division of their tendons. This is by no means all the evil produced by such system, for after section the mutilated limb is put in a shoe, and rotated as a whole outward. This instrument acts, as far as its rotating power is concerned, entirely on the ankle joint; no notice whatever being taken of the fact, that the malposture is primarily and principally developed at the medio-tarsal articulation; thus, even if the front of the sole be brought to the ground, the heel becomes misplaced, or such distortion is only resisted by the mortoise-like grip of the ankle, and many are the cases, in which that joint becomes seriously inflamed and injured. Moreover the foot being kept on an immov-

able basis, cannot have any play or action, and the muscles are left entirely inert during the whole period of treatment, while the paralysis, be it from fatty degeneration or other cause, is constantly getting worse.

The treatment I have adopted is founded upon the contrary idea of aiding and abetting the weakened muscles; but otherwise to leave the foot its full play so as to give them the best chance of recovery from their paralysis. The method adopted in these cases is similar to that already explained. In this instance the two peronei are to be supplied, the third may occasionally but very rarely want assistance; under any circumstances, only one piece of metal with a loop at its upper part is needed; it is to be carefully moulded to fit the limb. It must carry at the lower part of its posterior edge an eyelet, which has been nipped in the eyelet pliers as

PLATE XI.



THE TREATMENT OF VARUS, COMPLETE.

m, The upper end, with an eyelet-hole, of a trapezoid piece of plaister, the continuation of which under the circular pieces is marked by dotted lines, and which adheres over a rather broader surface of the sole than the insertion of the peroneus longus; *n*, the end, with the eyelet, of a piece of plaister, representing the insertion of the peroneus brevis; its continuation is marked with dotted lines at *n'*, as being split so as to embrace the base of the metatarsal bone;

for fixing it upon any substance, but is left barren, and this is to be fastened to the tin by twisting a wire through it, and through a little hole in the metal at the place named. The use of this arrangement will be seen immediately. Furthermore the slip of metal is to be included in slits in two pieces of plaister, after the manner explained (p. 84–86). The longitudinal piece of strapping is to adhere over the back edge of the fibula and the tin placed upon it.

On the foot we have to supply two tendons; the long peroneal runs with very slight obliquity across the foot at the bases of the metatarsal bones, this direction must be imitated by a tolerably broad piece of plaister, which may

o, circular strapping, covering but one piece of tin placed just behind the fibula, with its layer of plaister on either side; *r*, the remainder of the longitudinal strip of plaister brought down and adherent to the outside of the circular ones; *t*, an india-rubber spring assisting the peroneus longus; *u*, an india-rubber spring assisting the peroneus brevis; at the lower part of *u* is an arrangement for changing the direction of the force; this is better seen in Pl xii.; at *v* the end of the spring *t* is covered with tubing, as described at p. 71.

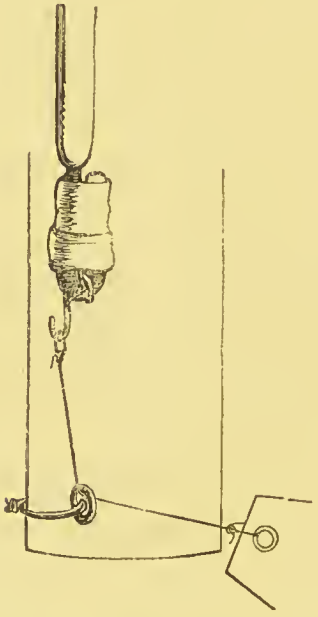
be continued, so that its end turns a little round the inner edge of the foot. The other end, which is to be folded down (sticky sides together), is to lie below the outer malleolus. The tendon of the peroneus brevis runs along the outside of the foot, and is inserted into the fifth metatarsal bone. But this surface is too small to give sufficient adhesion to the plaister, I therefore split the strip a certain distance, letting one part adhere to the dorsum, the other to the sole of the foot; this has the same effect as an insertion merely on the outside. The end to carry the eyelet is not to be prolonged backward so that it approaches too near the fibula.

All these arrangements being completed, the leg and foot are to be strapped as usual, taking care to leave uncovered the eyelet fastened to the tin. An india-rubber spring is simply to be stretched between the wire loop and the strip of

plaister representing the tendon of the peroneus longus; but it is more convenient to defer this until the arrangements for the other muscle have been made. The tendon of the short peroneus muscle makes a sudden angle below the fibula, playing round that bone like a pulley. This bend must be imitated, otherwise our supplementary force would not act in the direction of the muscular power. The eyelet, whose method of fastening to the tin has been described, is to be the pulley; a piece of catgut tied to the strip of plaister on the foot passes through it, and is attached by a loop to the india-rubber spring, by which means any desirable bend may be given. The arrangement, thus rapidly described, requires a little care in its adjustment; thus it is very necessary, when placing the plaister which represents the insertion on the foot, to bend the limb as near as it will go, without causing pain,

into the natural posture; also it will be necessary to tie the catgut very short; when this is difficult *in situ*, it may be

PLATE XII.



Represents the lower end of the tin, upon which, by means of a twisted wire, a barren eyelet has been fastened. Through this eyelet a piece of catgut runs from the piece of strapping to the hook in the loop of the india rubber spring. Upon this loop is a short bit of tubing, the lower end of which is turned up, displaying the hook, &c. When this part is turned down it completes the arrangement by covering the hook and preventing any possibility of slipping.

fastened to a hook (a common dress hook), so as to give an easier mode of

tying, and then this can be passed into the eyelet hole in the strapping.

Cases of talipes varus differ so much in origin and in form, that it is quite impossible to specify a distinct limit of time, during which they can be cured; the period for milder cases is about three months; but it must be remembered, that during this whole interval the patient is not confined. On the contrary, if of an age to walk, he can do so from the beginning, much better with, than without the appliance, and during the latter part of the time the lameness is scarcely, or not at all perceptible. I wish to insist strongly on this power of taking exercise, as being of very great importance, particularly if the paralysis have been severe, have lasted some time, or still continue; for it is evident that only by proper use can the muscles be prevented from becoming hopelessly atrophied and degenerated. It will take

longer than three months to overcome the lameness and deformity of the more strongly developed cases of varus by any proceeding hitherto in use, and however many be the tendons cut; and evidently therefore it is the more important to adopt a mode of treatment, which shall not keep the limb confined.

The time necessary for reducing the deformity in severe cases may, however, be very much shortened by the use of sudden extension under the influence of chloroform. This also is a procedure of my own adaptation to these diseases, and is one from which very great advantage may be drawn; but I would limit its employment to severe cases, and would caution surgeons against the use of violence, since when once the muscular power is annihilated by the anæsthetic very little force is required to place the foot in a normal position.

The method of procedure is as

follows ; a gutta percha or pasteboard splint is bandaged on the foot, and is allowed to harden or mould itself while the patient is taking chloroform ; as soon as the influence of the drug is perceptible, the splint is removed, and the surgeon waits a few minutes until the anæsthesia is fully marked ; he then grasps the posterior part of the foot with one hand, and the anterior with the other ; having first turned the latter a little more inwards, he proceeds to straighten it, rotate it outward, and abduct it. This is not to be done too quickly, but with a certain freedom of movement. In a very short time the surgeon finds, that he can cause the sole to face directly downwards, but that there remains flexion and adduction. A broad band along the sole, with a strongly marked edge internally, composed of the inner part of the plantar fascia and the abductor pollicis, checks further progress.

The resistance is to be overcome by holding the foot in one hand at the heel, in the other at the metatarsus, rendering this band quite tense, and then by giving a few quick, but not violent jerks in the direction of extension, causing it to yield. By this means the foot, unless advanced ossific changes be present, may be very quickly reduced to nearly a normal posture; but to fasten it to a splint in this position, would cause very severe, indeed unbearable pain; it must therefore be replaced in the gutta percha or pasteboard splint, previously moulded to the limb. On the third day, the appliance being removed, the foot will as a rule be found in a state to employ the strapping, springs, &c.; but if too much force have been used, the parts will have been bruised, and another day or two must elapse. This is always a disadvantage, hence I am most careful to use as slight force as possible.

By the combination of these two methods, the deformity may be reduced in a remarkably short space of time; a month has in my hands sufficed to bring the foot into position; but all treatment cannot be immediately discarded, since the muscular debility will probably still require support.

Certain cases of this deformity from paralysis come under care, when the patient is grown up: we can cure the malposture; but the paralysis being irremediable, lameness to a certain extent will persist, since some voluntary movements are impossible. Various shoes, irons, &c., have been used for the purpose of aiding progression; nothing hitherto invented approaches so nearly to the natural power, whose absence we would supply, as the caoutchouc springs in the direction and place of the absent muscles; and nothing so effectually aids and conceals the lameness.

CHAPTER IX.

TALIPES EQUINUS.

TALIPES EQUINUS has been regarded as a very simple deformity, and ascribed to contraction of the sural muscles, for which it has been assumed, that dividing the tendo Achilles was the simple and efficient cure. We have seen that the reunion of this tendon after its division was almost a certainty, but it nevertheless permanently weakens the muscle; nor is such procedure as a rule an efficient cure of the disease ; partly because the gastrocnemius and soleus are not the principal muscles affected, and generally have very little to do with the

malposture; partly because contraction is sure to recur.

It requires only a careful examination of a limb, thus distorted, to convince any unprejudiced surgeon of the truth of the above statement. Talipes equinus is rarely congenital, it arises chiefly in infants under five years of age; but may commence in much later life; for instance, I have a lad aged fourteen now under my care, in whom the distortion first made its appearance less than a year ago. We have, therefore, frequent opportunities of examining such a deformity, while still as it were nascent, at least quite recent, and of ascertained date. If the muscles, attached to the tendo Achilles, were the only offenders in this deformity, the foot ought to be extended as a whole; itself perfect in shape it should have only a malposture at the ankle-joint. This, however, is by no means the case; for one of the essential

characteristics of equinal deformity is the great dorsal prominence of the head of the astragalus, which is left uncovered by the scaphoid, through excessive flexion of the anterior on the posterior part of the foot; thus again we find that it is the medio-tarsal joint which is chiefly affected. The posterior half of the foot is occasionally drawn up a good deal (secondarily), in general only to a slight degree, sometimes hardly at all; but in all instances, and whatever may be the position of the heel, the prominence of the head of the astragalus is always strongly marked. I must caution my readers against mistaking an apparent disappearance of the heel behind the tibia for a phenomenon of extension, that is, for one of the essential causes of the deformity; because in reality this condition is not one of position, but of form; it is a secondary consequence of the disease. When the

deformity begins in early life, so that the patient has always walked on the

PLATE XIII.

TALIPES EQUINUS.

The straight position of the heel, and the malposition at the front of the foot, and the projection of the head of the astragalus are carefully copied from the model.

front of the foot, never used the posterior part, and never put the heel to the ground, this latter, deprived of its ordi-

nary stimulus to development, remains small and rudimentary, and is generally mistaken for a bone, so greatly extended, as to lie almost concealed behind the malleoli. When the malposition commences later, at four, eight or twelve years of age, at which periods the foot has already become somewhat formed, so that the development of the bones will not be instantly checked by any alterations in the conditions of their use, the os calcis never becomes thus apparently hidden; but remains prominent, and very much less extended than is generally supposed to be the case. If the reader will take the pains to examine cases or casts, and to look at dissected preparations, he will be convinced, that this deformity consists chiefly, or almost entirely in the flexion of the anterior on the posterior half of the tarsus, as above explained. If he will also look at the illustrations in ortho-

pædic books, I believe he will wonder that the doctrine of extension from the heel has ever been taught.

The cause of talipes equinus is, like that of the other pedal deformities, paralysis, the affected muscles being those supplied by the anterior tibial nerve, generally all of them, sometimes only two, never, I believe, as taught by tenotomists, the anterior tibial muscle only. The whole set thus supplied are extensors; but those intended to move the tarsus only are the tibialis anticus and the peroneus tertius; their antagonists are the posterior tibial and the long peroneal, which, when the anterior muscles have lost their power, bend down by their simultaneous ascendancy the front of the foot. This action produces that inflexion of a little more than a right angle at the medio-tarsal joint, which is the essence of talipes equinus. This fact accounts also for the breadth to

which the anterior part of the metatarsus attains; for the peroneus longus and a portion of the posterior tibial crossing the foot in opposite directions, are inserted respectively into the bases of the inner and outer metatarsal bones; their action, by drawing these bases nearer together, is to open out their distal extremities like a fan.

The tenotomist's treatment of this deformity is above all things to cut through the tendo Achilles, then to put the foot in a shoe with a rigid sole (as depicted at p. 49), provided with a screw that acts primarily, in fact entirely, on the ankle-joint. The iron sole of this instrument gives a certain support to the front of the foot, and does not permit its further contraction, but the screw cannot in any way increase the angle between that part and the posterior portion of the limb. In fact, the whole influence

upon the real causes of the deformity might be carried out just as well by a splint and foot-board, even without division of the tendo Achilles, which is not the true antagonist of the paralysed muscles.*

I do not mean to deny that occasionally, when there is either great want of development or great degeneration, it may be necessary to divide the tendo Achilles, but it should always be avoided if possible, since it is merely a temporary expedient which always leaves behind it a certain deformity (see p. 32 *et seq.*) Moreover by the use of chloroform much can be effected, even in de-

* Let me here also observe that if ever division of the peroneus longus and posterior tibial muscles be justifiable, it must be so in this case, when both of them are acting in causing deformity; but orthopædists find it quite simple to reduce this malposture without cutting those tendons, although they are the two strongest attached to the anterior tarsus; but they cannot overcome either a varus or a valgus without such an operation.

generated cases, as explained in the sequel.

My treament for this deformity is on the same principle as for others, namely, to act primarily on the part primarily distorted—the front of the foot. A single piece of tin placed upon a longitudinal strip of plaister in front, and to the outer side of the tibia, suffices, if it be rather broader than that used in flat foot, to furnish the origin of both tibialis anticus and peroneus tertius. The former is supplied by the wire loop at the top, as already described; the latter should be supplied by another loop on the outer side, halfway down the metal, and running longitudinally. In slighter cases, or in those which have already been partly conquered, even one spring of india rubber will suffice; but generally it is desirable to use two, adjusting their strength in the proportions which appear best to

correct the malposture; for in some cases the front of the foot turns a little in, in others a little out, and must be treated accordingly.

The insertion of the tibialis anticus has been described, that of the peroneus tertius is into the base of the metatarsal bone of the little toe, but in imitating this in plaister it is better to let the strip run under the sole. There is some difficulty in arranging these pieces so as to bind them down with strapping, that shall go all round and cover the whole foot, and yet not include the eyelet-hole-ends of the plaister; but if those ends be left short, and if the strips going round the foot be notched, where they cross the edges of the first named pieces, if advantage be taken of the bends in the metatarsus, in fact if a little ingenuity be used, the difficulty will be soon overcome. It will be well to mention that the patient

had better wear an ordinary low shoe, but, if from any circumstances, it be desired to use a boot, it will be more easily put on, if a piece of catgut be interposed between the spring and the plaister, so as to give more room.

The treatment by this means of talipes equinus is very successful, insomuch that patients express themselves on the first application as much more comfortable; they walk, too, with far greater ease, the shape of the foot rapidly alters, and it is generally reduced to its proper position in from six weeks to a longer interval. But the application must not be left off until there be some considerable improvement in the paralytic condition; which is to be promoted by encouraging the patient to walk, and to take all possible exercise.

I must repeat, that one of the great objections to houghing a patient is the necessity of keeping him at rest for a

month or six weeks after the operation, a procedure which offers to the paralysis every facility for getting worse. The heel is very seldom drawn up sufficiently to warrant tenotomy; most of the cases, in which there appears to be excessive extension at the ankle joint, arising rather from want of development than contraction. Moreover, these cases of apparent violently exaggerated extension may be benefited by judicious application of force, while the patient is under the influence of chloroform.

I must caution the surgeon against endeavouring to bend the ankle by applying force to the anterior tarsus. As soon as that part has been straightened, he must cease exerting any power on that portion of the limb; but must grasp the waist of the foot immediately in front of the tibia with one hand, and the heel firmly with the other. A great deal of flexion can be thus obtained by

vigorous and yet cautious proceeding. Of course the foot must be kept in the old posture for three or four days before springs can be applied.

CHAPTER X.

TALIPES CALCANEUS.

This sort of deformity is extremely rare, and I shall not detain the reader with its description, as I frankly confess, that although I have had large opportunities, whereof I have freely availed myself for several years, I have never seen a case of true calcaneus. It is, however, immediately the reverse of equinus, and results from the fore part of the foot being drawn up by the muscles in front of the tibia and fibula, those behind the bones having lost their power; this posture gives to the heel a pointed appearance, and causes it to look as though it sunk down. From my ob-

servations and knowledge of the pathological conditions of crural paralysis, I do not believe that the sural muscles themselves are often affected. If a case of this deformity came under my treatment I would supply the peroneus longus and the tibialis posticus in the manner described for varus and valgus, of course leaving out the anterior tibial supplied in the latter, and probably also the peroneus brevis supplied in the former case, but this must depend upon whether the foot have a tendency or no to turn in. There appears to me no reason to doubt that this treatment would answer, since my practice in all the other cases was founded upon the results of inductive reasoning, and the method has in my hands fulfilled the conclusion, to which that reasoning led me.

CHAPTER XI.

DEFORMITIES OF THE LEG.

Knock-knee or Genu Valgum.

We must now consider a set of deformities, which affect the legs, and for whose cure I have realized a new method, founded, I believe, upon better principles, and much more effective than any hitherto in use. We will first speak of knock-knee. It is not my intention to enter so minutely into the anatomy and natural history of this condition as into that of club-foot, but I must point out, that there are two sorts of knock-knee, which seem to me to arise from

different constitutional and local causes. The one always begins in early infancy, as soon or nearly as soon as the weight

PLATE XIV.

THE CURVED KNOCK-KNEE FROM A CHILD AGED SIX.

of the body falls upon the limb, and is combined with, and in all probability is caused by rickets. In such cases the shafts of the bones themselves are bent

in a peculiar manner, whose type never changes, although nature permits in this, as in all organic changes, slight variations within certain limits. The femur receives two bends, the upper half curves, so that the convexity looks forward and outward; the lower half in the contrary direction, its convexity looking inward and backward; at the same time it is twisted, so that what is normally its anterior face, and that which should be the front of the knee joint, looks abnormally outward. The tibia follows curves which are the exact inverse of those in the femur, the upper convexity looks backwards and inwards, the lower one forwards and outwards. Thus, the limb as a whole receives three curves, whose plan for both legs may be given as outward above and below, inward in the middle. In these cases the foot is valgous, that is, the toes look outward, and the patient walks on the inside of the foot.

To express in a few words the difference in form between the first and the second sort of knock knee, it might be said that one is a curved limb, and the other an angular limb. The second sort does not depend like the former upon curvature in the shafts of the bones; but upon some change near the knee-joint, which causes the tibia to slope abnormally outwards; but since the point of support must be as near under the centre of gravity as possible, this outward inclination of the lower part of the limb is compensated by an inward obliquity of the thigh. It has been frequently asserted that yielding of the internal lateral ligament causes this condition, by allowing the knee-joint to gape at its inner side. I cannot find the slightest grounds for such a statement; nor do I believe it possible for a joint to exist even a few hours under the supposed conditions. The actual locality

of the morbid change appears to me to reside in the lower epiphysis of the femur, and upper one of the tibia. Thus the angular bend is not a single one, situated at the articulation; but, as is seen on careful examination, the knee-joint itself and the bones a little over

PLATE XV.

THE ANGULAR KNOCK-KNEE, FROM A BOY AGED FIVE.

Much more marked in the left than in the right limb.

and under that point are in normal relationship, and the bend is a double one, situated above and below the knee at the situation of the epiphyses. The foot in these cases is generally slightly varous, that is to say twisted inwards, so that the sole rests pretty fairly on the ground, in spite of the misplacement of the tibia. This latter sort of deformity sometimes, indeed, not very infrequently, occurs in only one leg; the former is never, as far as my experience goes, otherwise than double.

In both cases the patient, when standing upright, places the knees close together, so as to allow them to support each other, and when in this position the limbs can be kept straighter, than if one foot be advanced in front of the other, so that the knees lose their mutual aid. In walking, these patients have a peculiar uncertain, waddling gait, partly produced by the distance of the feet

from each other, partly by the weakness of the limb, partly by the necessity of making each knee, as it is advanced, pass from behind, round the inner side, to the front of the other.

Bow-leg or Genu Extrorsum.

It appears quite impossible to say why some children's leg bones, being too soft should curve inwards, others should curve outwards, nor do I consider, that in a work of this kind, the question is of great importance. But it may be pointed out, that children with well developed rickets have not bow-legs, and although there is a soft-boned condition in these latter cases, and therefore a general appearance somewhat similating rickets, yet the condition is not true rachitis. Rachitis is a faulty mode of osteal development, the condition in bow-legs is deficient development. The

ossification itself is normal, and produces healthy bone; but it is so delayed that the epiphysal junctions remain very long; in fact, the shafts of the long bones continue cartilaginous till too late in life, and the weight of the body coming upon the legs causes them to yield. Children thus affected have a very odd mode of progression; the feet, but more especially the knees, are so wide apart, that the body has to be thrown from side to side at each step, and thus is acquired a quaint roll in the walk, that is very ugly, although at the same time rather comical.

A few children get well of these complaints as they grow up, but by far the larger number are never otherwise than cripples. Great importance is to be attached to early treatment, for as the bones harden, so will the difficulty of cure be increased.

Treatment of Deformities of the Leg.

The so called orthopædic method of treating these deformities, is to bind a padded wooden splint on the outside of the leg with webbing straps. That bond, which corresponds to the part of the limb most removed from the straight line, is pulled most tightly, in the hope of dragging that point nearer to the rectilinear splint. There is something in the extreme artlessness of this contrivance, which is almost touching, which would, indeed, be amusing were it not for the evils produced by its application. The Procrustean couch for each limb, into the shape of which the child's legs are to be rigidly dragged by the brute force of a buckle, has the additional inconvenience of keeping the knee-joint always stiff; thus the children afflicted with such treatment are obliged to walk in a par-

ticularly unnatural and fatiguing manner; being only able to lift the foot from the ground, by throwing each limb round the other, and the body, therefore, much over to the side at every step. They thus frequently fall very severely, so much so, that a patient thus treated, and who subsequently came under my care, had twice broken a limb, once an arm, and once a thigh, while thus crippled by her splints.

The method, which I employ does not confine the knee-joint, and substitutes an active resilient power for the stiff wood and inelastic strap. It is founded upon the idea of bending a straight piece of elastic steel (spring temper) to the same degree as the abnormal curve of the limb, fastening it, thus bent, to the leg, and then removing the retaining power, so that the tendency of the spring to become straight may exert a certain, and a plastic force, upon the

abnormal curve of the limb. If, instead of employing a single splint, we use two,—one for the thigh, one for the leg —and pivot these together at a place which shall correspond with the knee, we procure a spring action along the whole length of the limb, and allow that important joint perfectly free flexion. Of course, for the effective use of this apparatus, it is necessary that it should sit quite close to the limb, without the chance of slipping; and I am willing to confess, that I met with many difficulties in devising the best method of applying the above principle; but, having overcome these, I find the plan of treatment very efficacious. The spring splint must be made of steel plate about 9 gauge, well tempered, and from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches broad, according to the case. The hinge pivot must be quite flattened on one side: distant from it about half or

three-quarters of an inch, a hole is to be bored through both thicknesses of the spring, while the two portions are in a straight line with each other. This hole is intended to receive a little flat-headed pin, which will prevent the hinge yielding to the force we must employ by means of the clamp to be described, for giving the proper curve to the splint.

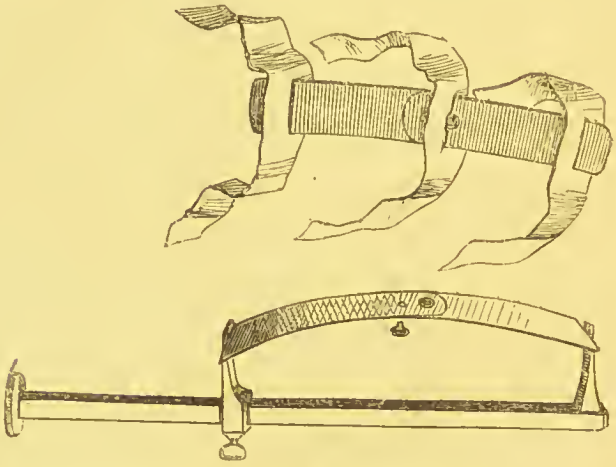
The clamp is simply a square iron rod, carrying at one end a projecting portion, which at its extremity comes to a blunt edge; just below this edge and parallel to it is a little groove. A similar projection slides up and down the staff, but, by means of a binding screw, can be kept fixed at any point upon it. When the spring splint is placed with its two ends in the notches of these projections, the movable stud is approximated to the other, until the spring is bent sufficiently, and then the binding screw is made to act.

Now, in the simpler cases, this spring having been padded, is merely to be carefully and smoothly strapped on the leg in the following manner: first of all, to prevent the possibility of slipping, we must take three strips of plaister,* one of which is long enough to encircle the thigh, another the knee, a third the ankle, and in each of them a slit is cut lengthwise, exactly as long as the steel is broad; one of them encloses the splint at either end, and one of them at the middle. The pin must be kept in the hole near the pivot, the splint bent in the clamp to the proper arc (a little more bent than the abnormal curve of the leg), a proper pad is to be placed between the skin and the steel; an assistant holds the clamp and the spring in the proper position, while the surgeon first tightly encircles the limb with the three strips of

* Empl. resinæ, spread on stout twilled calico.

plaister, and then straps up the leg carefully and smoothly. The foot must, of course, be included, otherwise it would swell. The whole should also be bandaged. The clamp

PLATE XVI.



THE APPARATUS FOR CROOKED LEGS.

Above is the spring, with plaister split, and fitted upon it. Below is the clamp holding the spring in a crooked position. The pin which keeps the hinge straight is shown as being just removed from the hole, whose position is also indicated.

is then to be removed, and the pin, which can easily be left uncovered by any plaister, must be taken out to give the hinge its liberty.

It happens, however, that most patients

require more careful arrangements, which vary in different cases. The rickety patient, *i.e.*, one with curved, not angularly bent limbs, also the patient with bow legs, must have something to modify the strain of the plaister upon the inner side of the limb, more particularly upon the upper part of the thigh. Children thus affected have very soft, flabby thighs, and the utmost care in strapping will not prevent the edge of the plaister cutting the skin. The mode, which I adopt to obviate this evil, is to mould on the inner side of the limb a couple of rather thin leather splints, one above and one below the knee; these, when dry and properly padded, must be included in the strapping that encircles the part and attaches the spring. If the child's thigh be very fat and soft, a roll of flesh is apt to hang over the upper edge of the dressing; it is therefore better to let that end of the

leather splint, bent somewhat outwards, project beyond the strapping, and to order the nurse to apply a little fresh cotton-wool or wadding, and to powder the thigh every night and morning. Again, the only part of the knee, which I find likely to excoriate is at the back, over the inner hamstring; a little prolongation of the upper leather splint downward may be made perfectly to protect this part, and at the same time not to interfere with the movement of the joint.

The above methods of adapting the splint are, I believe, the best possible in cases of the rachitic knock-knee, and the same leather splintage may also be used (is, indeed, quite as essential) in cases of bow legs, when the spring being applied to the outer side—*i.e.*, to the convex part of the limb—must of course be bent in the opposite direction.

The angular knock-knee is best treated

with another arrangement of the spring; for, as in the rickety cases we require the pressure to be exerted pretty uniformly over the whole length of the limb, so in these latter the force should chiefly expend itself in the neighbourhood of the knee. My method of carrying out this object is the following: at either end of each half of the spring a hole is bored, which permits the passage of a screw with a broad flat head, and a nut or female screw to fit. These four holes and screws are for the purpose of fastening upon the spring leather splints of far greater breadth, in the following way: two pieces of leather are to be moulded, by means of hot water with a little vinegar, to the outside of the thigh and of the leg, leaving between them an interval of an inch or more (according to the size of the patient) at the knee. They are then to be removed and placed upon a table in a straight line,

and with the same interval between them; through the holes in the steel marks are to be made upon the leather as guides to the places for boring through the splints, so as to admit the screws above described to pass through both leather and steel. The flat thin head of the screws must be kept on the inside, *i.e.*, next the leather; the nut must be fastened outside, sufficiently tight to join the two materials into one splint, which will be so broad as not to cut the skin; but, which will, nevertheless, make upon the morbid bend of the limb considerable pressure, chiefly concentrated by the restraining influence of the leather on the neighbourhood of the knee. These splints fit also so accurately, that as long as the faulty angle in the leg remains, it is scarcely possible that they should turn round upon the limb; nevertheless, and for more security, I always, before fastening

on the splint, pass the spring through three pieces of split strapping, as described at p. 148. At the second time of dressing, the thigh and leg piece must be unscrewed at one end and split strips of plaister put on each half of the springs; in these instances it saves time and trouble to put two pieces on each spring, one near the upper, the other near the lower screw.

Even with this arrangement, fat and flabby limbed children will frequently require that on the top and inside of the thigh a piece of thin leather should be placed; which generally need not be more than $1\frac{1}{2}$ or 2 inches broad. The above mode of arranging the splintage may occasionally be very usefully adapted to the application of these springs at the inner side of bow legs; a mode of use, which is sometimes desirable, because one of the abnormal bends in the upper part of the femur sometimes refuses to

yield like the other curves to the spring-power, while applied on the outside of the limb.

In whatever mode the spring be used, it must be carefully strapped to the limb, for very much of its comfort will depend upon smooth and even strapping, also on perfect and judicious padding. When, however, the surgeon has satisfied himself that the whole is properly arranged, he should first remove the little pin from the hole in the splint, and then displace the clamp. As this latter is freed, the limb assumes easily and without pain a very much straighter form; so that those unused to such cases are often surprised to see so great a change produced by so small a force. Before letting his patient go, the surgeon should grasp the thigh and leg, together with the splint, and bend the knee, so as to assure himself that the action of the hinge is free. The plaister will remain

on from ten to twenty days; when it gets loose the limb should be put into warm water; the whole application will then come off with ease, and the skin must be rubbed with the hand, protected by a little flour or other innocuous powder. When next the mother or nurse brings the child to the surgeon, she will probably volunteer, that the child walks much better with the splints on, and is less fatigued than without them. This is not to be wondered at, for the splint forms an efficient support to the leg, while it allows the knee to bend and all the time keeps up a constant active effort towards placing the limb in a normal position. After a few times dressing, the limb will be very evidently straighter and stronger; so that when the child stands, he does not require to keep the knees together for mutual support.

CHAPTER XII.

DEFORMITIES OF THE LEG.

Crooked Shins.

The peculiar unsightly shins of rickety children are occasionally unaccompanied by knock-knees or bow-legs; but more frequently are coincident with only a slight degree of either deformity. The conformation generally, however, of the skeleton, namely, large joint ends, exaggerated curves in all the long bones, and debility in the whole system, is such as indicates the morbid condition. When the general disorder can be overcome while the subject is still far below puberty, there is every possibility that a slight degree of curvature in the shins

will disappear with the growth of the body; but more developed curves will not do so, and will remain when advanced age shall have overcome their morbid cause. The very ugly form of the leg thus produced is frequently a cause of great annoyance to the adolescent and adult, as may be gathered from a case related by John Bell of a dancing master, who caused his shins to be filed down by a blacksmith, undergoing agony at the time, and subsequent torture from necrosis and exfoliations. Scarcely, however, had the wound healed, when observing that his legs were not as straight as could be desired, he applied for a repetition of the smith's art. Few people would have the courage of this dancing master; but the story shows how great may be the mental trouble produced by such distortion. Parents should be very careful not to allow their children to grow up with a

deformity, which a painless treatment may remedy; but which in after life may very probably be a cause of much mental distress.

The mode in which the tibia bends is rather peculiar; its greatest prominence is at the junction of the middle and lower third. The whole length of the diaphysis above this point is nearly straight; but at that place there is a bend so sharp that it is almost an angle, and of course the more advanced the case the sharper is the curve. Now, if we take this bend as the starting-point of our description, we may say that the shaft of the bone above and below slopes from that angle backward to an equal amount, so that the lower stands perpendicularly under the upper end of the bone; and it follows that the inclination of the upper part is only half that of the lower. Since, moreover, the tibia is jointed to the femur above, a com-

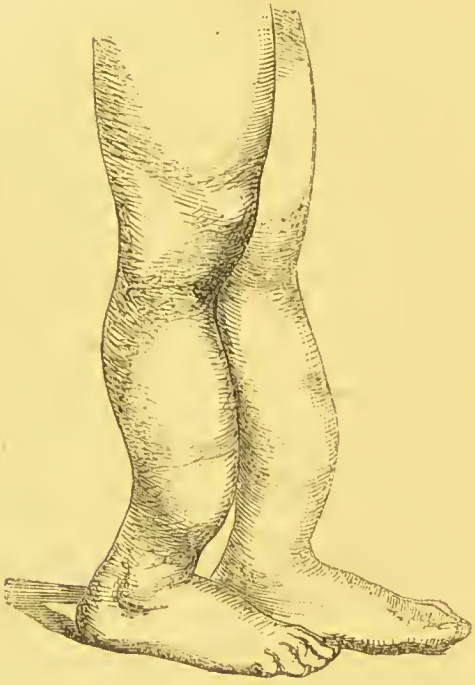
pensating curve is necessitated at the very incomplete epiphysal junction.

The rapidity of the backward slope at the lower part of the bone causes the profile outline at the back of the limb to run in the same line as the normal projection of the calcaneum; thus the heel looks as though it began one-third up the leg. Moreover, the lower articular surface of the tibia faces backwards; and thus, the ankle must be constantly flexed, in order to keep, while standing, the limb perpendicular on the ground; hence in these cases there is a peculiar secondary deformity of the astragalus, namely, an over acute angle at the neck. All these patients have very flat feet, partly produced by the above change, partly by approximation of the origin, and insertion of, therefore want of action in the anterior tibial muscle.

The method I have devised for the cure of the deformity, is an adaptation

of my spring splint to the part in question. The steel spring should be about an inch or an inch and a half

PLATE XVII.



CROOKED SHINS FROM RICKETS.

The peculiar curves of the tibia and the flatness of the feet are characteristic.

wide, plate-gauge from number seven to number ten, according to the power required, and of course it will be remembered, that the shorter the spring and

greater its bend, the more will be its power. For those cases in which the bone is peculiarly protuberant at the junction of the middle and lower thirds, it will be as well that the splint be of a trapezoid shape—*i.e.*, that it become narrower from above downwards: this arrangement will cause it chiefly to bend a certain distance below the middle, proportional to the amount of difference between the breadth of the two ends; thus the spring may be mathematically made to curve so as to fit exactly the shape of the bone. Previously, however, to bending the splint, two pieces of strapping must be slit sufficiently to embrace the iron—one above, one below; and then the spring may be set in the clamp, at the proper curve. On the other side of the limb a rather thin leather splint must be moulded, two sufficient pads are to be provided, and while an assistant holds the clamp and

spring in its place, the whole is to be carefully and smoothly strapped; of course the foot is to be included, and indeed must be bound rather tighter than the rest, since the spring will keep upon the plaister on the leg a considerable strain.

At the first dressing, the plaister must not be too tightly applied, or pain and sundry other inconveniences will be caused; but in a little time, if both the leather and the splint be nicely padded, the whole may be fastened with very considerable firmness.

The effects of the application soon become visible in a decided diminution of the curve in the limb, and in greater firmness of the gait. The length of time, during which the treatment must be continued depends altogether on the age of the patient and the amount of the deformity. If the strapping be carefully applied, if care be taken to keep the

leather splint of a perfect fit, and if the general health of the patient be attended to, the benefit of the spring force will be very soon apparent.

It is not consistent with the purpose of this book to enter into the treatment desirable in distortions of the joints, arising from disease or other causes. The principles, whereon such treatment is founded, are explained in my work on "Diseases of the Joints." Increased practice and experience, however, has led me to adopt certain expedients, which, as above stated, cannot be fully described in this volume. It will not be, however, out of place to observe that the more I see of anchylosed joints and of our powers of restoring them, the more am I persuaded that tenotomy or myotomy are very often much abused, and are, in point of fact, very rarely needed.

APPENDIX.

Cases illustrating Chapter VI.

Case I.

George Brown, aged 16, a thin, worn-looking lad, a blacksmith's apprentice, came to me at the Charing Cross Hospital, October 25, 1861, complaining of lameness, and of pain in the sole of the foot; he limped very much as he entered the out-patients' room, and was in evident pain. He said the foot was so tender, that he could hardly bear to put it to the ground; but that when he lifted it up the pain ceased, leaving only a numb sensation. Under these circumstances, I first looked for deep suppuration about the sole; but finding no sign whatever of such condition, I endea-

voured to discover what might cause such pain. Of course it had previously struck me that the foot was flat, but the pain was much more acute than is usually produced by such condition alone. However, finding no other means of accounting for the suffering, I proceeded to apply the apparatus, after the manner detailed at p. 66 *et seq.*, only taking care to add a soft but thin pad of cotton wool at the seat of tenderness. As soon as the india-rubber spring was in place, the boy was able to walk with but a slight limp, and with, as he said, but very little pain. I ordered iron and cod-liver oil.

November 22nd.—He had attended twice between the former and the present date; the limb has been dressed each time. The foot is in much better position, even when the appliances are removed; dressed the limb again, using a shorter piece of india-rubber.

December 18th.—The foot is in good position, and the arch remains when the appliances are removed. I recommended that he should try to go on without the dressing.

January 8th.—Came to say that he could get on perfectly well.

Case II.

W. S., aged 37, a gentleman who came to me April 10, 1862, has always led an active life, but severely sprained his foot sixteen months previously, while getting from the back seat of a dog-cart. This accident laid him up for some considerable time, and his health suffered, certain symptoms, apparently gouty, having developed themselves. He came to me on account of the remaining lameness and pain. He affirms, that at the time of the accident two tendons were broken; however, such occurrences are extremely rare, although they are often talked about. He complains of a feeling of weight in the foot, and inability to move it with freedom. In his gait I observed that the foot turned out, and was lifted from the ground and put down clumsily and heavily; he complained of pain on the inner side of the foot.

Examination of the limb when the boot and stocking were removed showed that the foot was very flat, the arch having quite given way. I could not find any anterior tibial tendon; whether utter paralysis in the muscle produced so lax a state in that tendon that it could not

be detected, or whether it had really been broken at the time of the accident, cannot now be discovered.

The posterior tibial muscle was also very lax and debile, still the edge of its tendon could just be felt behind the bone.

The foot was technically a flat foot, but its tendency to rotate outward was such, that the condition was evidently verging towards valgus.

I supplied the anterior tibial muscle only, according to the manner described at p. 66. He expressed himself as able to walk better.

21st.—The strapping, though not quite loose, no longer fitted sufficiently close to be of much value; moreover, although in actual hollowness of the arch the foot may be improved, its front looked even more abducted and rotated outwards than before; that is, these malpostures were rendered more evident by the changes, and the better position at the inner side of the limb produced by the treatment. I replaced the apparatus for the supply of the anterior tibial, and added another piece of metal and india-rubber, to imitate the posterior tibial muscle. Having applied the springs without much force, I gave him another for each part, that he might

change them in three or four days, and thus exert more power.

May 29th.—The apparatus fitted so well, that it was necessary to change it only once between this and the former date; the foot was very much improved, not only in form, but also in power and usefulness, even while freed from all aid and assistance. The fresh application was arranged to increase the power of the anterior tibial in proportion to that of the posterior tibial; and when the patient walked with the appliance so arranged, it would have been difficult to detect any lameness.

July 11th.—There was at this date no lameness perceptible; the apparatus had been discontinued for the previous week, and the only want of power remaining was greater tendency to fatigue after walking than in the other foot.

Cases illustrating Chapter VII.

Case III.

Anne Payne, aged 2 years and 3 months, affected with valgus sufficient to allow the inner ankle to come almost to the ground, was brought to me at the Charing Cross Hospital, April 19, 1861. I dressed the limb so as to supply the tibialis anticus. The child suffered no pain, but held the leg with an awkwardness that began to wear off before she left the room.

April 26th.—The position of the foot was better, and the arch more formed; still it was not quite right. I added another spring for the tibialis posticus.

May 8th.—I have seen this child twice since the last report; she placed her foot very much better—indeed, the mother thought that she was cured.

June 7th.—The child walked quite straight. Discharged.

Case IV.

Alice Weston, aged 16, came to me at the Charing Cross Hospital, May 17, 1861. She

had a considerable degree of valgus of the right foot, and walked very lame, which prevented her getting a situation. The inner malleolus was very protuberant, the arch of the foot quite gone, and she suffered severe pain under the scaphoid and internal cuneiform whenever she bore any weight on the limb.

May 22nd.—The strapping had somewhat excoriated the skin, and the edge of the tin pressed a little over the tibia, where it begins to enlarge towards the malleolus. There was a little excoriation or blister (separation of the cuticle) in that situation. The old pain under the sole was hardly to be complained of. In dressing the part again, I applied lint with a very little simple ointment over the excoriated part, and bent the lower end of the tin a little outward, placing one of the circular pieces of strapping between it and the dressing.

June 10th.—Has been seen twice since the last report. On the 3rd inst., when she last attended I observed that the action of the succedaneum for the anterior tibial was too great in proportion to that of the posterior. I made the necessary change in this respect. The pain under the scaphoid was quite gone.

She walked from Peckham to the hospital, while, two months ago, she had been quite unable to walk more than a few yards.

July 29th.—The patient had been here of late only every fortnight. She had a situation, and could not come so often as before. The foot was very nearly straight, the arch was still rather low, but very little lower than in the other foot.

August 21st.—Discharged cured.

Case V.

William Anstey, aged 42, came to me at the Charing Cross Hospital, 9th May, 1862, suffering from lameness in the left foot, which had come on without apparent cause, and had gradually increased, until he could not, at that date, follow his employment.

As he walked, even with the boot on, his gait was very characteristic: the foot turned very much out, and the knee fell inward, so that the leg sloped outwards, the knees being nearer together than the ankles. The foot was lifted up and put down again in a very awkward, lumpish manner; not only the foot itself, but the ankle-joint also appeared

stiffened. When the naked limb was examined, the abduction and rotation of the front of the foot was very evident, also the turning outwards of the ankle-joint. The outer malleolus was almost hidden, the inner one prominent; also the bones of the tarsus below that part appeared swollen and enlarged. The pain is both at the ankle-joint and at the sole; on trying to flex or extend the ankle, considerable pain is produced. I applied the apparatus as described at p. 82, and with the immediate effect, as he said, of making him walk a good deal better, and without pain.

21st.—The plaister on the foot had become loosened; he therefore returned. The gait was somewhat improved, and he affirmed that he could keep about longer. Re-applied the plaister to the foot, and increased considerably the power of the spring which supplied the posterior, and somewhat also that which imitated the anterior tibial muscle. A mixture containing two grains of quinine was ordered to be taken thrice a day.

June 23rd.—It had been necessary to renew the application once between this and the former date. The man was in very little

pain, and able to walk much better and further without fatigue. The foot also was in perfect position while the apparatus was applied, but on its removal it partially relapsed. Again increased the tightness of the springs.

July 16th.—The foot would at this date remain in posture after the springs were removed; but on making him walk, it became evident that there was still some tendency to turn out. The posterior tibial alone was replaced, and he was ordered to take more exercise—if possible, long walks into the country; the tonic was changed for iron.

August 1st.—The paralytic or very weakened condition of the posterior tibial muscle, which had caused great delay in the cure of this case, was evidently yielding; the position of the foot remained, after removing the application, so good, that it became very doubtful whether it was necessary to renew the dressing. However, I wished to be quite safe; and therefore the strapping, &c., was re-applied.

19th.—The man at this date might fairly be pronounced well.

Cases illustrating Chapter VIII.

Case VI.

Jane Evans, aged 10 months, was brought to me at the Charing Cross Hospital with a non-congenital varus of a somewhat severe description, January 18, 1861.

It appeared that a little less than a month previously the child had had some fits, and that the foot then seemed turned a little; that nine days ago she had a more severe fit, and then the foot became worse. Some arnica, ordered by a homœopathic practitioner, had not produced any peculiar effect.

There was a strong bend in the middle of the inside of the foot, and the line of the toes was rather perpendicular than horizontal. There was also a great projection of the cuboid.

I dressed the limb in the manner described for supplying the long and short peronei. The application of the spring to the strap which represents the long muscle had a very marked

effect in turning the sole down and unfolding the medio-tarsal bend; the influence of the other was less obvious, but still effective.

January 23rd.—The foot was more changed in shape than I had expected; the mother was obliged to take off the spring during the first night or two, but not afterwards. The leg had been washed and rubbed for some time; there was a little abrasion under the end of the tin. I dressed the limb again with a little pad of lint over the abraded part, and applied a little more power.

30th.—Foot a good deal better in form; the first night, the spring being tighter, was taken off to give the part rest; but after that time it was not found necessary to remove it.

March 19th.—The history of this case consists simply in a constant gradual improvement; the child was on that day nearly a year old; when she was placed standing, but supported, on the table, the sole of the foot was still found to turn a little to the inner side. The inversion was, however, but very trifling, and slight force obliterated it; the inner margin of the foot was also a little hollow. The same apparatus was re-applied so as to turn the foot almost

into a valgous position, and the mother was told to let the child begin to feel its feet.

April 3rd.—The child's foot was perfectly restored. Discharged.

Case VII.

Margaret Lynch, aged 3½ years, came into the Charing Cross Hospital, with varus of the left foot, and was placed under my care February 18th, 1862. The child was of a very irritable temper, and cried through the greater part of the day, and nearly all night, although she was undergoing no treatment, and was kindly managed.

The varus was congenital. The sole looked inward and backward; the cuboid and the external malleolus projected much; the internal malleolus was hardly to be seen. The foot was so twisted, that when the child was held erect on the right foot, and persuaded to put the other to the floor, the malleolus very nearly touched the ground; the cuboid was made the point of support, and the great toe nearly touched the inner edge of the tibia.

February 22nd.—I began to treat this child,

supplying the peroneus longus and brevis with india-rubber springs; even a slight force made a good deal of change.

24th.—I supplied shorter india-rubber, for the purpose of making more extension. The foot was already improved. I had her dressed, and encouraged to walk about.

28th.—The foot was much improved, and the medio-tarsal bend unfolding. I readjusted the apparatus. The child had become wonderfully good since the 24th; but had taken to crying during the night, and, as I had a severe operation in the ward, I sent her out of the hospital.

March 20th.—Strapping was readjusted only for the foot on the 6th; she was then able to walk very fairly, while the sole came well to the ground, but she had a tendency to turn the foot in. I somewhat inverted the malposition, and told her parents to encourage her to walk. She had grown very much better tempered, and the calf had much increased in size.

April 22nd.—There was only a gradual improvement to report in the position of the foot; the child walked at this time very fairly. She was, however, out of health, had been growing

very fast, and had bowel irritation with debility; the hot weather seemed to be one cause of these ailments. After a little aperient medicine, cod-liver oil and steel were ordered, and the india-rubber left for a day or two rather less tight.

May.—In the middle of this month the child's foot was quite restored. The patient had been kept in bed during only the first two days of the treatment.

Case VIII.

J. P., aged 6 months and 2 weeks, came to me August 30th, 1862. The patient was sent to me by Mr. Fennell three months ago; but owing to some domestic troubles, the above period was allowed to elapse before my advice was sought.

The child had very severe congenital double equino-varus, the anterior tarsus was very much twisted and adducted, so that the great toe lay close to the inside of the tibia, and the sole looked backwards. There was a prominence over the head of the astragalus, but this process was not so large as it ought to be; however, it was still round, and there was no grating. The deformity, however, was, for so young a child,

remarkably obstinate, resisting any attempt at reposition with the hand.

Some curious points in the etiology of this case are worth recording, though in general the histories which women give of their sensations, &c., during pregnancy, are not to be relied on; but this person appears peculiarly free from fanciful tendencies, or from liability to exaggeration. When she was about six months gone with child, her husband was attacked with a severe convulsive fit, in her presence, which left him insensible for some days, from which state he recovered with complete paralysis. Now the mother assured me, that just after the convulsive attacks had passed, she was conscious of very violent and prolonged movement of the fœtus, which lasted about half an hour; this recurred twice during the afternoon. That then, she thinks, for more than a month afterwards, she felt nothing of the child, and fully imagined it to be dead. About three weeks or a month before her confinement she began to feel feeble movements; these increased in frequency and power until parturition—the child being born with double club-foot.

Applied the apparatus as described at p. 111, *et seq.*, using very little force; indeed, for about ten minutes, springs exerting only a few ounces pressure were applied; their power gradually drew the foot a little straighter, when slightly more powerful springs were substituted.

Sept. 17.—The child's feet were certainly straighter,—re-applied the apparatus with stronger springs.

October 27.—At the two visits between this date and the last, there has only been necessary to remark gradual improvement. Indeed, there was nothing else to be observed. A little more difficulty had arisen from the greater abduction of the foot: this rendered it somewhat difficult to fasten, on so small a thing as a child's leg and foot, the plaister representing the insertion of the peroneus brevis, so that the end to which the catgut was fixed did not come against the eyelet secured to the tin representing the pulley. This is a difficulty, which always occurs in children's cases. I find it best overcome by cutting the plaister, which is to represent the above-named tendon, of a **Y** shape, stretching it in the hand that it may not give way on the limb, turning down one of the

ends, leaving it very short, and fastening the eyelet in it, while the other two ends are made to adhere—one on the sole, one on the dorsum of the foot, leaving the inner metacarpal bone uncovered. In these cases also, in spite of any difficulty in knotting it, the catgut must be tied very short, the spring too must be as short as possible.

Nov. 28.—The child's feet, with the springs attached, were at this date in good position; but without much power; they still both turned and twisted somewhat inwards—not, however, in a degree comparable to their condition three months ago. If the child were of an age to walk, the weight of the body coming on the inner side of the feet everted by the instrument, would aid very much in confirming the proper posture.

January 6.—The feet were now very nearly restored, so little do they turn in when the apparatus is removed, that any one not knowing there had been deformity, would probably consider the position as the effect of habit. The apparatus was re-applied. Although posture was restored, we must wait for its confirmation till the age for walking.

Case IX.

H. C., aged 10, the son of a medical man, has been ever since birth more or less under the cure of orthopædists, having been born with equino-varus of the right foot. During this period the anterior and posterior tibial, and the flexor longus digitorum have been cut, the tendo Achilles has also been divided. He has been kept in bed for two and three months at a time; he has worn irons on the limb, which rendered walking laborious and painful.

When I saw him he was still lame, he could not put the heel to the ground; the toes turned sometimes a little out when the foot was set down, but as a rule they are turned much inwards; altogether the gait is most uncertain, and the foot swings very loose at the end of the leg.

On examination the foot is found to be bent at the middle, slightly adducted, but a good deal rotated inwards; the ball of the toe was abnormally spread out, and broad. There was very little or no power of flexing the foot, or, indeed, of changing its position in any way; it hung loose. Both the thigh and the leg were

very small. On examining with the finger, I was unable to find the anterior tibial tendon, nor the edge of the posterior, which ought to be plainly felt in so spare a subject.

My opinion, as expressed to the young gentleman's father, was as follows:—That I feared the power of all the muscles whose tendons had been cut (except the tendo Achilles) was permanently destroyed; that therefore the foot would never entirely recover; but that if assistance by my method were given, he would be able to take exercise with the foot in a natural position, and thus acquire strength in the other muscles, and more power of guiding the foot; that by degrees both the deformity and the want of power would be much remedied; but how far this amelioration might go, I could not say.

Sept. 20, 1861.—I applied an apparatus to the foot, very much as for equinus. The boy could walk a great deal better; however, he was very fidgetty, and said it hurt him.

22nd.—A little fold was found in the strapping, under the bend of the sole, and this had somewhat fretted the skin; the boy walked much better with the apparatus applied.

12th October.—I saw him walking in the street, and was much pleased to see how well he could go. The heel could then come to the ground, and he was, he said, much more comfortable with the apparatus than without it.

Case X.

G. S., aged 14 months, was brought to me with a congenital varus of the left foot, Sept. 27th, 1862. On account chiefly of family reasons, the foot has not been attended to; but at this time Mrs. S. was very anxious that the deformity should be cured.

The varus is of the highest degree, the tarsus being very much twisted and inclined inwards, so that there was a deep furrow on the inner side, and the great toe nearly touched the tibia. The front part of the sole faced backwards, and the cuboid would have been the point of support for the body, had the patient been able to walk. That bone was the most projecting part of a very sharp convexity on the outer side of the tarsus. The tendo Achilles formed a curve, with the convexity looking inwards; but such curve was very slight when compared to

the twist of the anterior tarsus. The head of the astragalus was quite distinct; it was very fairly developed, and round.

Endeavouring with my hand to put the foot as much into form as possible, I found the resistent power very considerable. Explained that much time would be saved by giving this child chloroform, and by the action of the hands placing the foot as nearly as possible in the normal posture. At the same time, that the limb would not remain in that position, but must undergo further treatment.

October 2nd.—Chloroform was administered, and during the time of its inhalation a gutta percha splint moulded on the limb. As soon as the influence became marked, the splint was removed, and, when anæsthesia was fully established, the foot was straightened in the following manner. The heel, the malleoli, and the posterior part of the foot were firmly held in the left hand, to prevent any possible twist being given to the ankle-joint. The front part of the foot was grasped in the right, and brought slowly towards a normal position. With the exercise of but very slight power, the foot could be straightened very much nearer its

true position than it could have been brought, previous to the exhibition of chloroform, by the exercise of great force : however, at a certain point, there was a decided check to any further replacement. A quick, firm, yet by no means violent movement of the right hand, overcame this resistance with a slight sound. Some adduction of the front upon the back half of the foot was then the only remaining malposture; between the ball of the great toe and the heel was the usual sharp edge of a tight band—a couple of slight jerks overcame the resistance in this part.

By the above methods the foot was reduced into a shape that was very nearly normal, as long as held in the proper posture; and even when released it returned but very little towards the malposture. Before the child recovered from the influence of the chloroform, the splint, having been thickly padded with cotton wool, was re-applied; the part of the foot not covered by the splint was also protected and kept warm by a thick cushion of wool placed next the skin, and held in position by the bandage.

5 p.m.—The child was fretful, and the skin

was a little hot; but the evidences of pain were very slight. A hot bath was ordered, of course with the proviso that the foot must be kept out of the water.

4th.—Yesterday, the child, who is naturally unquiet, was rather more fretful than usual, but not markedly so. To-day he seemed quite in his ordinary condition. I removed the splint, and examined the foot. The position was the same as the original deformity, which is, of course, attributable to its having been put in a splint of that form; but the limb, instead of being rigid, was loose, and could be turned easily; however, as motion outwards appeared to cause some pain or uneasiness, the splint was re-applied.

6th.—Neither rotation outwards nor adduction, even to a position very near the normal, appeared to cause any pain. The springs were applied after the manner detailed at p. 111, *et seq.*

15th.—On the 10th a shorter india-rubber spring had been supplied in the place of the peroneus longus. The foot was this day in tolerable position; the sole looked directly downwards, but the front half of the foot was

somewhat adducted on the back part. The appliances were re-adapted, and more tension exerted upon the catgut representing the tendon of the peroneus brevis.

29th.—The child's foot was at this date very nearly restored to a normal posture. Still shorter springs were employed, so as to reverse the deformity, and he was to be encouraged to try and walk.

November 18th.—The foot was very much better. The springs employed were so short as rather to evert the foot, *i.e.*, to place it into a valgous position; however, when the springs were removed, the limb fell slightly into the varous posture. He could walk a little; indeed, considering that he had never attempted it before, he had made considerable progress in the past fortnight.

December 20th.—The child had been diligently taught to walk, and the foot had gained greatly; in fact, it was now straight, and acted normally in walking without the springs. However, the apparatus was applied for the last time to-day, the foot still put rather into the valgous condition.

Cases illustrating Chapter IX.

Case XI.

Thomas Alsop, aged 12, was brought to me at the Charing Cross Hospital, April 4th, 1862, with double pes equinus. He was idiotic, could not talk, violent in temper; but was said to have been healthy, mentally and bodily, until fits came on at the time of teething.

In each limb the muscles anterior to the tibia were all paralysed; the front of the foot was bent very much down, while the heel was scarcely drawn upwards, there being a bend of almost a right angle at the medio-tarsus; and a line drawn from the roots of the toes to the heel was much shorter than it should be. The heel projected normally, and was of natural size. In progression this patient leaned very much forwards, and planted the foot on the ball of the toes; as the weight fell on that part, the plantar angle increased—*i.e.*, the bend diminished.

I applied strapping and the india-rubber springs to the limb, according to the manner specified, with the effect of drawing up the

front part of the foot considerably nearer to the normal posture. The plantar fascia, and no doubt also the muscles and tendons, were rendered tense; the boy did not appear in pain, but he gesticulated much, and pulled at the strapping. When made to walk, the feet came better to the ground; but he held the knees awkwardly.

April 14.—There had been very much difficulty in managing this boy; he picked and pulled at the plaister; he was of dirty habits, and the strapping got wet; it became loose, and was taken off three days previously; nevertheless, the shape of the foot was improved. Re-applied the strapping; told his grandmother, who came with him, to let him have woollen gloves fastened on the hand, to prevent his picking off the plaister.

23rd.—The plaister having been wetted, became loose, and was taken off a day or two since; the boy walked better; re-applied; gave directions for more careful watching.

19th May.—Have seen this boy two or three times. His foot was a good deal improved; his grandmother was about to take him from town, and place him under some guardianship,

as for certain family reasons he could be no longer kept in the house.

This was the first case of equinus I had treated without cutting the tendo Achilles. The difficulties here were extraordinary, and, owing to the condition in life of the parties, insurmountable; yet the improvement in the shape of the foot and power of walking was such as to give me the greatest encouragement.

Case XII.

James Burt, aged 14, a weakly-looking lad, came to me at the Charing Cross Hospital, September 26, 1862, with talipes equinus of the left foot, arising from complete paralysis of the muscles anterior to the tibia.

The front of the foot was drawn down, so that the sole was doubled in two at about a right angle; the heel being hardly elevated; the projection of the head of the astragalus was very strongly marked, the scaphoid having left it almost bare. The heel was hardly at all raised, and projected normally. The leg was very much shrunken, and all the muscles at the

back of the leg were weakened. The condition of the deformity was somewhat singular; for when the foot was lifted from the ground the front half fell into a complete equinus; but when the weight fell on it the deformity diminished, and the heel approached the ground more nearly than would be expected. On lifting the foot, the front of it fell again, and the deformity re-established itself.

The condition of the muscles and their degree of sensitiveness to the magneto-electric machine was tried; the response of those at the back of the tibia and of the fibula was rather feeble, but quite distinct. The action of some in front of the leg was doubtful. It appeared that the extensor longus digitorum was capable of slight action, also the extensor of the great toe, but the anterior tibial did not contract at all.

I applied the apparatus and the spring after the method described at p. 128. A slight degree of force exerted by the india-rubber was sufficient to put the foot into very fair position, and it appeared to me best to use but a small amount of power at first. He walked much better with the apparatus on.

24th October.—The bend in the sole had

diminished, and the tension of parts in that place, which prevented the foot being straightened, was considerably less; re-applied the apparatus, putting on a shorter spring.

December 22nd.—There have been two visits since last report, and each time the shape of the limb has shown improvement. Made him walk without the apparatus; it was evident that he had acquired more power of raising the anterior half of the foot. Again tried the magneto-electric spark. The muscles generally responded better to the stimulus; the anterior tibial had now certainly regained some power, for, when the current was directed through it, its tendon stood out in relief. Re-applied the apparatus with a still shorter spring.

January 14th.—The alteration in the shape of the foot was quite remarkable; it was very nearly straight, and the power in the anterior tibial had greatly increased. In fact there was little lameness remaining, except that when the spring was removed the front part of the foot came to the ground a little too soon.

February 13th.—The boy had not returned between this and the former date. The foot was quite restored, and even when the spring

was removed he walked without limping; however, in order to be quite guarded against any relapse, the spring was re-applied.

Case XIII.

G. Taylor, aged 9, was brought to me, 5th June, 1862, for a deformed foot. He had fits six years ago, and the foot had become distorted, the change becoming more and more marked with the lapse of time, and was stated to be on the above date at the worst.

The distortion was equinus, with a slight twist inwards of the anterior foot, such as frequently accompanies that deformity. The bend at the sole was well marked, and the prominence of the head of the astragalus on the inner side of the dorsum very distinct. The heel was small and somewhat drawn up; the former condition, a result of deficient development, gave a fallacious appearance of excessive extension at the ankle joint; that this joint was extended, was evident from the above-mentioned position of the heel, but the posture was by no means strongly marked, and was attributable to the action of the peroneus longus and

posterior tibial, which acting primarily on the front of the foot would secondarily raise the heel. The sural muscles would soon adapt themselves to the interspace between origin and insertion, shortened by the above position of the calcaneum; just as they did when our grandfathers and grandmothers artificially raised that part of the foot by high-heeled shoes. Thus, though the above muscles take no active part in the production of equinus, yet when they have shortened to the position of extension, they resist any attempt to replace the foot in a normal posture.

5th.—I applied an apparatus for equinus as described p. 128, employing relatively more force in the place of the peroneus tertius than of the tibialis anticus, on account of the inward twist of the foot.

14th.—The position of the anterior foot is somewhat improved. On a fuller examination, than I had yet given to the limb, I was struck by the probable difficulty that would arise in endeavouring to depress the heel through the medium of the anterior tarsus; cutting therefore the tendo Achilles appeared to me unavoidable, until the idea of stretching the muscles under

chloroform, presented itself to my mind. I therefore proposed this procedure.

17th.—During the administration of chloroform, I had moulded to the foot and leg a leather splint; when the anæsthesia became complete and the splint had been removed, an assistant held the leg steady while I grasped the instep immediately in front of the malleoli, letting the fingers and thumb on either side of the foot run diagonally downwards and backward, toward the lower part of the heel, which was also held laterally and at the back by the left hand. The posterior tarsus, being thus encircled, was without much difficulty bent upwards by a few short but not violent jerks; the heel though still small was got into good position, and the axis of the back part of the tarsus was at right angles to the leg; but, not content with this, I placed the ankle into the posture of flexion. The anterior tarsus was then treated in the same way; and thus the posture of the foot was altogether restored. While the patient was still unconscious the leather splint was replaced, so that the foot lay in the old position. The bandage was to be kept wet with cold lotions.

20th.—Some pain, for which an anodyne had

been ordered, had resulted from the operation; the patient slept well, and the next day suffered only from the nauseating effects of the chloroform. On removing the splint and moving the foot gently up and down, some pain was experienced; I put on the spring, &c., very loosely, leaving shorter springs to be applied in the course of the following day. I afterwards heard that the pain went off, but the boy would not put his foot to the ground for three days more, and even then did so in a very gingerly manner.

8th July.—The shorter springs have been kept applied for the last few days, and the patient has walked about; the foot has improved immensely in position. Re-applied the apparatus with still shorter springs; after it had been on a day or two, he was able to walk in it with scarce any perceptible limping.

12th August.—Although for some time past the patient had been able to walk well without any appliance, the springs have nevertheless been retained, in order entirely to accustom the muscles to work thoroughly in their new position. However, every thing is now so well in place that all mechanical aid is discarded.

This is I believe the first case of talipes that has ever been treated by stretching the resistant muscles under chloroform. I was very anxious about the case; but the result was such as fully to justify my procedure.

Cases illustrating Chapter XI.

Case XIV.

Curved Knock-knee.—Mary Hughes, aged 6, was brought to me at the Charing Cross Hospital, May 26, 1862, with weakness of the legs.

She was placed upon the table, and her dress being lifted, shewed considerable deformity of the limbs. The double curves in the thigh and leg were strongly marked; the knees were kept together for mutual support. These conditions caused the outline of the two thighs together to look at their upper part broader, at their lower narrower than normal; while the outline of both shins is reversed, namely,

narrow above, broad below. The child had also what are called "calf-knees," *i.e.*, the joints allowed too much extension, they "bent back;" such malposture frequently, but not invariably accompanies a curved, and therefore a flexible condition of the bones.

I cut out in paper carefully measured patterns for hinged splints, as described at p. 146, giving the gauge as No. 10,* and arranged that the child should be brought back again when the appliances were ready. In the mean time she was ordered to take the following three times a day.

℞ Ferri potassio-tartratis, gr. v.
Calcis phosphatis, gr. v.
Aquæ menthæ pip., ℥j. M.

June 4th.—The child was brought back again, and the splints having in the meanwhile been finished, were carefully applied.

13th.—The little girl's mother said that the

* The reader should understand that the wire gauge and plate gauge are not only different but absolutely contrary; in the former the higher numbers are the smaller sizes; in the latter, No. 1 is the smallest size, No. 24, I believe, the largest. I have always used for these springs either 7, 8, 9, or 10.

child had been walking better, but for a day or two past has been complaining a little, in fact the right splint seemed to hurt her somewhat over the malleolus. A small hole was carefully cut in the strapping near the edge of the splint, and sufficient cotton wool was stuffed in under the spring, with the blunt end of a probe; this expedient seemed entirely to relieve the pain.

July 16th.—The child's limb has been dressed once between the two last dates; it is much straighter, and the child walks greatly better.

Sept. 17.—It does not appear worth while to follow the details of gradual alterations in this case; the child's gait and strength improved by degrees, and after the above date she ceased to attend.

Case XV.

Anna R——, aged 5, was brought to me November 26th, 1861, with crooked legs of the curved description. The child was very fat and rather flabby, having soft flesh, and a good deal of it. I had previously been baffled by this condition of body, and had resorted to many expedients to enable such patients to

continue wearing the splints. I resolved in this case to commence at once by protecting the child's flesh as much as possible against being rubbed by the plaister. For this purpose I moulded a piece of thin leather on the inside of the thigh, and another on the leg; the former was cut at its lower end, so that the back portion descended lower down than the front, and protected the skin over the inner hamstring. The leg piece was cut at its upper part in a contrary direction, so that a projecting piece in front, passed above the nether portions of the upper splint. Thus, though no continuity of leather splintage could obstruct the movements of the knee, the inner part of that joint was entirely protected against the plaister.

Dec. 3rd.—This arrangement, together with the longer splints that had been already made according to my pattern, I strapped on the limb at the above date.

13th.—The child was said to have been very comfortable, and to have walked much better. The strapping was removed the day before, and the child's legs well washed both then and on the above named day. Apparatus re-applied.

Feb. 11th, 1862.—It is scarcely advisable to follow day by day the gradual improvement of this case; by the above date the child was able to walk very much better, and the limbs had very considerably improved in shape. Even without the splints the power of walking was much increased, and there was far less of the awkward waddling which had before so distressed the parents. I re-applied the apparatus as before.

April 15th.—The improvement in shape and power of the child's legs has been gradual but constant. At the above date the limbs were so nearly straight that an acute eye was required to detect any lack of symmetry; the child's gait was very good—a little feeble perhaps, but without waddling. This is the most rapid case of the sort I have had; the local treatment had been so managed as to produce no abrasion or soreness of the skin. The general health had been improved by various tonic medicines, such as iron, quinine, cod-liver oil, &c., alternately exhibited.

Case XVI.

George Moss, aged 4 years and 8 months,

was brought to me at the Charing Cross Hospital, February 3rd, 1862, with crooked legs. The boy was very weakly; his legs were thin, and when he was placed on the table and the clothes lifted, the limbs were found to have a very sharp curve about the knee. This was much more marked in the left than in the right limb. Both thighs were thin, and the flesh was very soft; by that expression it is not intended to designate the skin and the subcutaneous tissue merely, but the whole mass surrounding the bone. The inner side of the thigh was remarkably deficient in bulk and firmness, a condition which would point to want of power in the adductor mass, whence perhaps some part of the deformity. I cut out patterns in paper for a pair of steel splints, to be made of No. 10 gauge; that is, they were to be thick springs for so small a child; but then only one-and-a-quarter inch broad. In each half of the spring there were holes above and below, each provided with a flat-headed screw and nut.

March 2nd.—The splints having been made, the child came to have them applied. First two pieces of leather about one-sixth or one-eighth inch thick were cut, so that they would

respectively cover, when moulded, about one quarter of the circumference on the outside of the thigh and of the leg, the two together clothing the whole length of the limb, except the knee, from hip to ankle; much thinner leather was cut, similarly to protect an equal amount of surface on the inner side of the limb. These four pieces having been steeped in hot water, were bandaged in their proper situations on the thighs and legs, so that they moulded themselves to fit their surfaces accurately. These splints being removed the outside ones were placed on the table in a straight direction, leaving, however, between their proximate ends the same interval as separated them when *in situ*;—the spring splint was then placed upon the leather, and through the holes in the former pencil marks were made on the latter, as guides for boring holes, through which the screws passed, and fixed the leather and the steel together, making them as it were into one splint.* The arrangement of split strips of plaister according to the plan described at p. 147, was then carried

* These splints and appendages I made myself, as this was the first case which I had thus treated, and I desired to arrange everything rightly; the method of

into effect, and the whole, carefully padded, was strapped on each limb.

It is to be observed, that in this form of appliance, the splintage covers two separate quarters of the circumference of the limb at any given part, thus there remain two quarters, one in front, the other at the back, for the adherence of the plaister. This amount of skin surface is generally quite sufficient, but if it be thought desirable to secure more room, the breadth of the inner leather may be diminished.

March 28th.—The splintage had fully answered the purposes expected of it; there was no excoriation, and the child had been quite comfortable, and walking better.

October 3rd.—The improvement throughout this case had been very slow; at one time, moreover, the splints had to be discontinued for six weeks or more, on account of an attack of measles. However, the limbs were at the above date, quite straight, or at least so nearly so that it was deemed unnecessary to continue

arrangement being once fixed, an instrument maker can fashion the whole apparatus for any other cases according to given directions and patterns.

the local appliances further. The general treatment had been of the tonic and nutrient kind.

Case XVII.

Eliza Sturgess, aged 7, was brought to me at the Charing Cross Hospital, with bow-legs, March 28th, 1862. The child is a strong-looking little creature, broad-chested, with a fine colour, and round cheeks; but the legs are terribly crooked, so much so that when she stands the distance between the two knees is nearly as great as the breadth of the haunch from hip to hip. I carefully cut paper patterns, that the mother might order some steel-hinged splints, and at the same time I directed that leather should be moulded to the inner side of the leg and thigh, as described at p. 149, and in Case XV.

June 9th.—The splints, &c., were carefully strapped on the limb.

August 29th.—The improvement in this case was at first very slow; but the treatment has been steadily persevered in, the apparatus being re-applied about every fortnight. For

some reason that I cannot comprehend, the deformity began, about three months previous to the above date, to yield more rapidly, and at that date, the limbs were very fairly straight, indeed, the thighs were so little curved, that it appeared to me unadvisable to continue with the long-hinged splint; but as there was still an awkward bend outward near both upper and lower epiphysal junctions of the tibia, I applied a short tibial splint below.

November 28th.—The same industrious method has been employed with the short as with the long splint. The child's legs appeared at this date so nearly normal that further splintage was considered unadvisable.

Cases illustrating Chapter XII.

Case XVIII.

Martha Hodges, aged 5, was brought to me with extremely crooked shins, 9th August, 1861. The child had large joint ends to all the long bones, and the peculiar formation of skull,

which is significant of rickets. The weak condition of circulation and the pallor of the child prevented my adapting a splint at once. Tonics were given; cold bathing, instead of washing in hot water, and a nutritious diet were prescribed.

September 2nd.—The child being stronger and less pallid, I had previously let some splints (gauge 7) be made; they were strapped on with gentle pressure this day.

October 7th.—I, having been in the country, had not seen this child since the first application of the splint. The mother told me that she walked greatly better, and that the legs appeared straighter. I could not pretend to carry in my mind the outlines of her limbs, among many carefully-observed deformities; and could not assert that there was or was not improvement. The splint re-applied.

December 30th.—After such an interval, I could, without danger, affirm that the shins were very much straighter. The child's health was very considerably improved: this was in part to be attributed to the tonics and general regimen, in part to her being able to walk better and take more healthy

exercise. I now had the splints bent and re-tempered, by which device I obtained additional power; for when, by means of the clamp, they were bent to fit the shin into a curve contrary to that in which the steel had been tempered, the force of the spring was, of course, increased by the difference between the straight line and the permanent curve of the metal.*

January 8th, 1862.—The increased power of the splint has caused the plaister, where it is strained most tightly by the spring action, to gall the skin on the back and inner side of the leg. The application of the splints was discontinued for some days, during which the skin again became sound.

20th.—During the last twelve days the skin has been aided to heal and harden by means of an astringent lotion. Before re-application of the splints, a piece of thin leather was moulded on the leg at the back. The result of thus increasing the power of the spring without

* This plan is very useful when the bone becomes so nearly normal in shape that an ordinary straight splint would exert no force, but when nevertheless it may be desired to continue treatment.

modifying the other parts of the apparatus, shewed me that it would in all cases be advantageous to protect by leather the skin exposed to the greatest power of the splint. I have not neglected the precaution since.

May 16th.—Not quite three months previous to this date there occurred a marked improvement in the shape of the child's legs. The splints have in the meantime been constantly applied—the renewal occurring about every fortnight, or twice in five weeks. From the above date it was exactly nine months since the child came under my care. The treatment has certainly been very tedious and troublesome, and at times almost disheartening; but the mother has always been pleased with the greater ease with which the child could walk, and at this date, as the legs were nearly or quite straight, I myself in discharging the patient from treatment felt satisfied with the result.

Case XIX.

A. M., aged 9.—The case of this boy is very similar to that just narrated; but, in consequence of certain differences, it will be described in

relationship to Case XVIII. In the first place, the patient, who came to me March 3rd, 1862, was older, and the health did not appear so disordered: on the other hand, the bones were less crooked, but naturally were larger, and therefore probably stronger; and, particularly at the point of greatest curvature, they were thickened by deposit of additional substance behind, partially filling up the depressed angle. This is a very constant condition in rickets.

I ordered splints to be made of No. 9 gauge, directed that leather should be moulded to the back of the limb; and when these preparations were complete, the splint, being duly bent in the clamp, &c., was carefully, not too tightly, strapped on the limb. This case continued in much the same way as the last, but not so long: in five months I had the splint bent and re-tempered, and in another two months I could discharge the boy from care.

Case XX.

Charlotte Brown, aged $7\frac{1}{2}$, was brought to me with very crooked shins, July 16th, 1862. The angle of the bone, as well as its whole

anterior edge, was very sharp—so much so that I feared the result of allowing the splint to press immediately on that portion of bone: I therefore only tried one of the springs, and that with but slight pressure, which, however, as I feared, became in a few hours unbearable. I therefore had a hole made at the top and at the bottom of each splint, and screws with nuts, as described at p. 158, fitted to each: when this was complete, a piece of wash-leather was moulded on the shin, forming a case for the bone. On both sides of this sort of sheath the leather was cut nearly across in three places at the sides;* namely, at the point of greatest bend—also in one place above, in another below this situation, leaving only the front part uncut. The object of thus dividing the leather was to prevent the material, stiffened by the bends into which it was moulded, counteracting the force of the spring. The metal splint was now bent in the clamp, and through the above-described holes, marks were made on the leather, where holes, or rather slits, broad enough to admit the screw, and long

* This was necessary, even while it was being moulded, to avoid a fold.

enough to allow a little play lengthwise between the two splints. The back of the leg had been already provided with leather coverings, and the whole apparatus being nicely padded, and the steel being received into slit strips of plaister, was strapped without great pressure upon each limb.

It was never expected that this child could be entirely cured, *i.e.*, that the limbs would be made entirely symmetrical. However, the improvement is up to the present time greater than I expected, (February, 1863,) and I begin to see that the girl's legs, if not quite equal to the requirements of beauty, will not, at all events, be disagreeably ugly.

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